Institute for European Environmental Policy

PROVISION OF TECHNICAL SUPPORT RELATED TO TARGET 2 OF THE EU BIODIVERSITY STRATEGY TO 2020 – MAINTAINING AND RESTORING ECOSYSTEMS AND THEIR SERVICES

ENV.B.2/SER/2016/0018

Guidance on achieving no net loss or net gain of biodiversity and ecosystem services

Final – July 2020

Authors

This guidance was primarily written and prepared by Graham Tucker (IEEP), Fabien Quétier (BIOTOPE) and Wolfgang Wende (Technische Universität Dresden).

Additional contributions were received from Hans van Gossum (IEEP) and Marianne Darbi (now at Helmholtz Centre for Environmental Research – UFZ).

Recommended citation: Tucker, G.M., Quétier, F. & Wende, W. (2020) *Guidance on achieving no net loss or net gain of biodiversity and ecosystem services*. Report to the European Commission, DG Environment on Contract ENV.B.2/SER/2016/0018, Institute for European Environmental Policy, Brussels.

Acknowledgements

We are grateful to Anne Teller and Rayka Hauser of the European Commission who managed the contract and provided valuable comments on drafts of this guidance.

Disclaimer

This study was carried out under European Commission Directorate General Environment Service Contract number: ENV.B.2/SER/2016/0018, by a consortium led by the Institute for European Environmental Policy (IEEP) and also involving UNEP-WCMC, Trinomics and IUCN.

Lead contractor

Institute for European Environmental Policy

London Office
11 Belgrave Road
IEEP Offices, Floor 3
London, SW1V 1RB
UK
Tel: +44 (0) 20 7799 2244
Fax: +44 (0) 20 7799 2600

Brussels Office
4 Rue de la Science
B- 1000
Brussels
Belgium
Tel: +32 (0) 2738 7482
Fax: +32 (0) 2732 4004

Contents

LIST OF ACRONYMS....5

1 INTRODUCTION TO THE NO NET LOSS GUIDANCE....6

1.1 Aim and structure of this guidance document....6

1.2 Policy background....6

1.2.1 The EU's 2030 biodiversity commitments and supporting actions....6

1.2.2 The EU Biodiversity Strategy for 2020....9

Action 5 on mapping and assessing ecosystems and their services....10

1.2.3 Action plan for nature, people and the economy....10

1.3 Objectives and scope of these guidelines....11

1.3.1 The objectives of this NNL guidance....11

1.3.2 Scope and limitations....12

2 KEY PRINCIPLES AND STRATEGIES FOR ACHIEVING NO NET LOSS OF BIODIVERSITY AND ECOSYSTEM SERVICES....15

2.1 The need for no net loss objectives and measures....15

2.2 The mitigation hierarchy....15

2.3 The appropriateness of biodiversity and ecosystem service trade-offs....20

2.4 The appropriate scale of measuring no net loss....21

2.5 Year for baseline....23

2.6 Sectoral coverage....23

2.7 Mainstreaming biodiversity and ecosystem service objectives into policies and programmes....24

2.8 Stakeholder involvement....29

3 GUIDANCE ON AVOIDING AND MINIMISING IMPACTS....30

3.1 Spatial planning....30

3.2 Strategic Environmental Assessment....35

3.3 Environmental Impact Assessment....39

3.3.1 The EIA process....39

3.3.2 Mitigation measures to avoid and minimise impacts....44

3.4 Ecosystem services and SEA/EIA....45

4 GUIDANCE ON OFFSETTING IMPACTS....47

4.1 Key principles and essential design considerations....47

4.2 Deciding on whether compensation is required....50

4.2.1 The scope of the NNL or net gain objectives....50

4.2.2 Conditions and thresholds....52

4.3 Deciding on what type of compensation is allowable....53

4.3.1 Exchange rules....53

4.3.2 Mechanisms for offsetting losses and ensuring additionality....55

4.4 How much compensation is required?....57

4.4.1 The use of metrics to calculate losses and potential gains....57

4.4.2 Target-based offsetting....65

4.4.3 Dealing with uncertainty – the use of risk multipliers....66

4.4.4 Incorporating time lags into measurements....67

4.5 Deciding on where offsets should be located ... 67
4.5.1 On-site versus off-site considerations and offset combinations ... 67
4.5.2 Locating offsets strategically in a landscape context: German examples at various spatial levels ... 70
4.5.3 Pooling offsets / habitat banks ... 74
4.6 Deciding on when offsets should be delivered ... 76
4.7 Implementation arrangements ... 77
4.8 Defining roles and responsibilities for different stakeholders ... 78
4.9 Defining implementation options ... 79
4.10 Building confidence in implementation ... 81
4.11 Ensuring effectiveness and long-term benefits ... 83

5 REFERENCES ... 85

ANNEX 1: Glossary of key terms ... 96

ANNEX 2. POTENTIAL ADVERSE IMPACTS ON BIODIVERSITY FROM BUILT DEVELOPMENTS, AND POSSIBLE INTERVENTION MEASURES TO AVOID, REDUCE AND COMPENSATE FOR IMPACTS ... 100

LIST OF ACRONYMS

See Annex 1 for a glossary of terms

BES	Biodiversity and Ecosystem Services
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CEF	Connecting Europe Facility
EAFRD	European Agricultural Fund for Rural Development
EEA	European Environment Agency
EIA	Environmental Impact Assessment
ELD	Environmental Liability Directive
EMFF	European Maritime and Fisheries Fund
ERDF	European Regional Development Fund
ESF	European Social Fund
MAES	Mapping and Assessment of Ecosystem Services
MSP	Maritime spatial planning
NNL	No Net Loss (of biodiversity and ecosystem services)
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SPA	Special Protection Area

1 INTRODUCTION TO THE NO NET LOSS GUIDANCE

1.1 Aim and structure of this guidance document

The overall aim of this guidance is to support the EU 2030 Biodiversity Strategy's objective of putting EU biodiversity on the track to recovery for the benefit of people, climate and the planet by 2030.

In particular, this guidance document aims to identify key principles and best practices involved in addressing negative impacts of human activities on biodiversity and ecosystem services (BES) in order to achieve no net loss (NNL), or, more preferably, a net gain in BES. It covers the avoidance, minimisation, restoration and offsetting of impacts in accordance with the mitigation hierarchy. However, to complement existing guidance on implementation of the Birds and Habitats Directives, and avoidance and mitigation measures (e.g. through Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA)) it primarily focusing on BES offsetting, especially outside the Natura 2000 network. It builds on work carried out in the framework of the EU 2020 Biodiversity Strategy which aimed to halt the loss of biodiversity and ecosystem services, and restore them to the extent possible, by 2020.

The guidance consists of the following sections:

- Section 1 provides an overview of the main EU policy objectives and related initiatives of relevance to the aim of achieving NNL of BES, and also sets out in more detail the objectives of this guidance and its scope and limitations.
- Section 2 describes the key principles and strategies for achieving BES NNL.
- Section 3 provides guidance on avoiding and minimising impacts, including through strategic spatial planning, strategic and project-related impact assessments, and the use of appropriate mitigation measures.
- Section 4 provides guidance on BES offsetting, including key principles and practical issues relating to the type and amount of offsetting required, the location of offsets, the mechanisms for achieving them, the governance and the roles of different actors, and the arrangements to ensure the long-term effectiveness of offsets.

1.2 Policy background

1.2.1 The EU's 2030 biodiversity commitments and supporting actions

The EU Biodiversity Strategy for 2030 was adopted in May 2020 with the overarching aim to put the EU on the path to recovery for the benefit of people, climate and the planet. It sets commitments and actions to be delivered by 2030 in the EU, including:

- Establishing a coherent **Trans-European Nature Network** of protected areas to cover 30% of EU land and 30% of EU seas, connected with ecological corridors and Green Infrastructure. This network should include Natura 2000 sites as well as nationally protected areas. At least a third of it would consist of strictly protected areas of very high value for biodiversity and for climate change mitigation and adaptation.

- An **EU Nature Restoration Plan**, which launches a process for the development of binding targets to restore degraded ecosystems across the EU, and sets concrete commitments to reduce or eliminate key direct drivers of biodiversity loss by 2030, and to manage ecosystems sustainably.
- A set of measures to **enable a transformative change**. These include strengthened biodiversity governance to ensure delivery on the 2030 targets, better tracking of progress and ownership of commitments across policy areas, sectors and governance levels. It also aims to improve the knowledge base on biodiversity, increase and better target financing and investments, and ensure that nature is respected in public and business decision-making.

The Strategy also presents a blueprint for the EU's position, and sets the EU's level of ambition at the negotiations on the post-2020 global biodiversity framework that will be adopted under the Convention on Biological Diversity (CBD) in early 2021. It prioritizes biodiversity in EU external actions, from Green Diplomacy through trade to international oceans governance, in order to underpin the EU's contribution to tackling the **global biodiversity challenge**.

The EU Biodiversity Strategy for 2030 is one of the core initiatives of the European Green Deal, the EU's new strategy for green, sustainable and inclusive growth, which will also guide the efforts for economic recovery following the Covid-19 crisis.

The EU Biodiversity Strategy for 2030 refers to the need for the world to commit to net gain, so that our societies give nature back more than they take away from it. A number of the Strategy's commitments provide avenues for strengthened restoration action and for the implementation of the mitigation hierarchy to potential negative impacts in public and business decision-making. These include in particular:

- ***EU Nature Restoration Plan:***

  In order to ***strengthen the EU legal framework for nature restoration,*** the Commission will propose in 2021 binding EU targets to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters. The impact assessment underpinning this proposal will identify a range of options to ensure that EU ecosystems are restored so that they can support biodiversity as well as deliver a wide range of benefits to people.

  In addition to launching the development of a legal restoration instrument, the Strategy puts forward concrete commitments as part of the Nature Restoration Plan in relation to: restoring agricultural areas, freshwater and marine ecosystems and protected species and habitats; combatting soil degradation and sealing, bringing back pollinators, planting 3 billion trees in full respect of ecological principles, greening urban areas and ensuring synergies of biodiversity, climate and renewable energy objectives. The application of the NNL and net gain approaches can greatly contribute to delivering this broad and ambitious restoration agenda.

- *As part of **Enabling transformative change**, the Commission will strive to build an integrated and whole-of-society approach.*

  To ensure that environmental and social interests are fully embedded into **business strategies**, the Commission will present a new initiative in 2021 on sustainable corporate governance, including human rights and environmental duty of care and due diligence across economic value chains. It will also support the development of a European **Business for Biodiversity movement** through its existing Business@Biodiversity platform. Particular attention will be paid to measures to **incentivise and eliminate barriers for the take-up of nature-based solutions**.

  Under **Invest EU**, a **dedicated natural capital and circular economy initiative** will be established to mobilise at least €10 billion over the next 10 years from public and private finance. Nature and biodiversity is also a priority for the **European Green Deal Investment Plan**. The **EU sustainable finance taxonomy** will help guide investment towards a green recovery and the deployment of nature-based solutions. In 2021, the Commission will adopt a delegated act under the Taxonomy Regulation to establish a **common classification of economic activities that substantially contribute to protecting and restoring biodiversity and ecosystems**. This will be further supported by a Renewed Sustainable Finance Strategy which will help ensure that the **financial system contributes to mitigating existing and future risks to biodiversity** and better reflect how biodiversity loss affects companies' profitability and long-term prospects. The Commission will further promote **tax systems** and **pricing** that reflect environmental costs, including **biodiversity loss**.

  The **integration of biodiversity considerations into public and business decision-making** at all levels will continue, building on existing work, in particular the EU guidance on integrating biodiversity and ecosystem services into decision-making (see next chapters). To complement and further develop this work, the Commission will develop in 2021 methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use. These will include measuring the environmental footprint of products and organisations on the environment, including through life-cycle approaches and natural capital accounting. In this context, the Commission will support the establishment of an international natural capital accounting initiative.

The above initiatives will encourage and help public and private decision-makers to better assess and mitigate potential negative impacts on biodiversity, as well as to improve their positive contribution to biodiversity. This guidance can provide concrete technical support in this regard.

1.2.2 The EU Biodiversity Strategy for 2020

While this guidance document will directly support actions to implement the EU Biodiversity Strategy for 2030, it builds on work undertaken under the EU 2020 Biodiversity Strategy, and in particular its Target 2, as explained below.

The EU Biodiversity Strategy to 2020[1] aimed to halt and reverse the loss of biodiversity and ecosystem services by 2020. Among its targets and actions was **Target 2: By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.**

Target 2 related to all ecosystems and their services. It complemented the Habitats Directive[2] provisions aimed at maintaining and restoring favourable conservation status of species and habitats of Community interest[3], and similar provisions for all birds under the Birds Directive[4]. Target 2 envisaged that restoration should be for the enhancement of ecosystem services as well as for biodiversity, in other words for restoring natural capital.

The actions to implement Target 2 of the 2020 Strategy are summarized below (**Box 1-1**).

Box 1-1: Actions to support Target 2 on ecosystem maintenance and restoration

Action 5: Improve knowledge of ecosystems and their services in the EU
5) Map and assess the state of ecosystems and their services, assess their economic value, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020.

Action 6: Set priorities to restore and promote the use of green infrastructure
6a) Develop **a strategic framework to set priorities for ecosystem restoration** at sub-national, national and EU level.
6b) Develop a Green Infrastructure Strategy to promote the deployment of green infrastructure in the EU, including through incentives to encourage up-front investments in green infrastructure projects and the maintenance of ecosystem services.

Action 7: Ensure no net loss of biodiversity and ecosystem services
7a) Develop a methodology for assessing the impact of EU-funded projects, plans and programmes on biodiversity.
7b) Propose an initiative to ensure there is no net loss of ecosystems and their services.

---

[1] Communication on our life insurance, our natural capital: an EU biodiversity strategy to 2020, COM(2011) 244 final. Hereafter referred to as the 'Biodiversity Strategy'.
[2] Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.
[3] These are habitats and species listed in Annexes I, II, IV and V of the Habitats Directive.
[4] Directive 2009/147/EC on the conservation of wild birds; codified version of Directive 79/409/EEC.

Action 7: Ensure no net loss of biodiversity and ecosystem services (NNL)

These guidelines have been developed in support of Action 7 of Target 2, which is to ensure NNL.

The NNL initiative was given impetus by the Council Conclusions of December 2011[5], which agreed 'that a common approach is needed for the implementation in the EU of the NNL principle', and by the European Parliament resolution of April 2012[6] urging the Commission to develop an effective regulatory framework based on the NNL initiative, taking into account the past experience of Member States while also utilising the standards applied by the Business and Biodiversity Offsets Programme (BBOP).

To take the initiative forward, the Commission established a NNL Working Group, which completed its work in July 2013, producing reports on the 'Scope and objectives of the no net loss initiative' (NNLWG, 2013b) and 'Development of operational principles of any proposed EU no net loss initiative' (NNLWG, 2013a). The Commission also published a number of studies to inform the initiative, including on NNL policy options (Tucker *et al.*, 2014), the potential impacts of the policy options (Tucker *et al.*, 2016) and design elements for biodiversity offsets (Rayment *et al.*, 2014). A public consultation was carried out by the Commission in 2014, with the results published on the DG Environment webpage[7].

Action 5 on mapping and assessing ecosystems and their services

Action 5 is also relevant to the subject of these guidelines. It was designed to provide a knowledge base to support other actions of the 2020 Biodiversity Strategy. The Mapping and Assessment of Ecosystem Services (MAES) Working Group produced a series of technical reports, the fifth of which (2018)[8] provided an integrated analytical framework and a set of indicators for mapping and assessing the condition of ecosystems in the EU.

All Member States are actively involved in mapping and assessing the state of ecosystems and their services in their national territory. An integrated EU ecosystem assessment developed under MAES is to be published in 2020.

1.2.3 Action plan for nature, people and the economy

In 2016, the Commission published a comprehensive evaluation of the Birds and Habitats Directives[9]. The evaluation confirmed that the Directives are fit for purpose, but achieving their objectives requires a substantial improvement in their implementation, working in partnership with different stakeholders across the EU.

---

[5] http://data.consilium.europa.eu/doc/document/ST-18374-2011-INIT/en/pdf

[7] http://ec.europa.eu/environment/nature/biodiversity/nnl/results_en.htm

[8] https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/5th%20MAES%20report.pdf

[9] SWD(2016) 472 final.

To this end, in 2017 the Commission adopted an Action Plan for Nature, People and the Economy[10], which outlined 15 actions under four priorities to increase implementation quickly and efficiently by the end of 2019.

Action 1b (Improving guidance and knowledge and ensuring better coherence with broader socio-economic objectives), committed the Commission to develop and promote EU guidance on integrating ecosystems and their services into decision-making at local, regional, national and EU levels, and provide capacity building measures for authorities, planners and developers. The guidance published in 2019 (European Commission, 2019a) provides an overview of the wide range of benefits that flow from nature, and the steps and available tools to assess and better integrate these benefits in policy and planning decisions, including a set of practical tools to this end.

The mitigation hierarchy, biodiversity offsetting, NNL and similar goals are also included in ongoing discussions between parties to the CBD. The zero-draft proposal for the post-2020 biodiversity framework[11] suggests achieving 'no net loss by 2030 in the area and integrity of freshwater, marine and terrestrial ecosystems, and increases of at least [20%] by 2050, ensuring ecosystem resilience'. This lays the foundation for a growing role for mitigating and offsetting of development impacts on biodiversity to achieve national-level goals. It could lead to an acceleration of the discussion on a global no net loss goal (Maron *et al.* 2020).

1.3 Objectives and scope of these guidelines

1.3.1 The objectives of this NNL guidance

This guidance contributes to Action 1b of the Action Plan for Nature, People and the Economy. Its principle objective is to increase the consideration of BES in decision-making by public and private actors.

Its specific objectives are to provide guidance on:

1. principles and good practice in applying the mitigation hierarchy (i.e. 'avoid-minimise -restore-compensate hierarchy') with regards to BES in key planning and decision-making processes;
2. appropriate procedures for the design, implementation and enforcement of offsets and habitat banks, including addressing related risks; and
3. BES capacity needs and capacity building opportunities.

While the guidance covers all components of the mitigation hierarchy, its primary focus is on the last stage of this hierarchy, i.e. biodiversity offsetting. It neither replaces nor re-interprets any existing Commission guidance on avoidance and mitigation measures as part of the implementation of EU legislation, e.g. on SEA, EIA and the Birds and Habitats Directives.

[10] SWD(2017) 139 final.
[11] https://www.cbd.int/article/2020-01-10-19-02-38

It complements the European Commission's 2019 guidance on integrating ecosystems and their services into decision-making; where further details on ecosystem services and the methods and tools for mapping, measuring and assessing them can be found. It also takes into account related guidance on the deployment of EU-level green and blue infrastructure (European Commission 2019b), which defines criteria and available technical and financial support instruments that can help planners integrate natural landscape features into strategic green and blue infrastructure.

1.3.2 Scope and limitations

These guidelines do **not** replace, modify or reinterpret any legal texts relating to EU legislation.

These guidelines relate to BES in the EU, including the largely artificial or semi-natural habitats and associated species communities that result from interactions with human activities. They are also based on the biodiversity policy framework within the EU, and in particular the EU Biodiversity Strategy to 2020, and the Birds Directive and Habitats Directive.

It should be stressed that these guidelines do **not** address the requirements for avoiding and compensating for impacts relating to Natura 2000 sites in accordance with Articles 6.3 and 6.4, or species receiving strict protection under Articles 12 and 13 of the Habitats Directive (**Box 1-2Box 1-2:**). For the latter, the Commission has guidance[12] on how to evaluate any impacts on Natura 2000 objectives (see **Box 1-3**) and for specific sectors such as wind power, forestry or non-energy extractive industries.

Box 1-2: Key aims of the Birds and Habitats Directive and Member State obligations regarding the assessment of potential impacts of activities and their compensation

The principal aim of the Birds Directive (Article 2) is to ensure that 'Member States shall take the requisite measures to maintain the population of the species referred to in Article 1b[13] at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.'

The Habitats Directive includes a number of requirements for Member States to implement conservation measures for habitats and species of Community interest[14]. The general purpose of such measures should be to achieve the overall aim of the Directive, stated in Article 2(1) as 'to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies.'

Article 2(2) then states that 'Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna

[12] http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

[13] All species of naturally occurring birds in a wild state in the European territory of the Member States to which the Treaty applies.

[14] These are habitats and species that are listed in Annex I and II of the Directive, respectively.

and flora of Community interest.' Favourable conservation status can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well.

These Directives give the legal EU basis for the protection and management of sites of particular importance for species and habitats of Community Interest. These comprise Special Protection Areas (SPAs) designated under Article 4 of the Birds Directive (for birds listed in Annex I of the Directive and for migratory species) and Special Areas of Conservation (SACs) designated under Article 4 of the Habitats Directive (for habitats and species of Community interest). These SACs and SPAs are combined under Article 3(1) of the Habitats Directive with the intention of forming 'a coherent ecological network' referred to as the Natura 2000 network. However, it is important to note that favourable conservation status has to be achieved across each species' and habitat's natural range, and not just within the Natura 2000 network.

The Birds and Habitats Directives require the establishment of measures to ensure the appropriate management and protection of sites. In particular, Article 6(3) of the Habitats Directive requires plans or projects that are likely to have a significant effect on a Natura 2000 site to undergo an 'appropriate assessment', and only be approved if the assessments ascertain that they will not adversely affect the integrity of the site. Article 6(4) includes provisions that allow projects or plans that may have adverse impacts to go ahead if they are of overriding public interest and there are no alternative solutions. In such cases the Member State 'shall take all compensatory measures necessary to ensure that the overall coherence of the Natura 2000 Network is protected'. Thus, there are clear legal requirements to address residual negative impacts through measures that would appear to contribute to achieving NNL at least at the network level, but not necessarily at a site level.

Under Articles 12 and 13, Member States should take the requisite measures to strictly protect the species listed in Annex IV throughout their natural range within Europe, including through the prohibition of their deliberate killing, capture, picking, or collecting; deliberate disturbance; deliberate destruction or deterioration of their breeding sites or resting places; and their keeping, sale and transport.

Box 1-3: European Commission guidance documents of relevance of the achievement of no net loss of habitats and species under the Birds and Habitats Directives

Documents available on the DG Environment website page on Natura 2000 management[15]:

- Guidance document on Article 6(4) of the Habitats Directive 92/43/EEC. Updated version November 2018.
- Guidance document on the strict protection of animal species of Community interest under the Habitats Directive 92/43/EEC. Current version from February 2007 is being updated.
- Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. 2001. Managing Natura 2000 sites: The provisions of Article 6 of the Habitats Directive 92/43/EEC. 2000.

[15] http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

The current guidance therefore focuses on achieving NNL of all BES outside the Natura 2000 network. This reflects the Council conclusions, which indicate that the NNL objective should apply to 'areas and species not covered by existing EU nature legislation' and the European Parliament's Resolution which refers to the 'importance of applying such an approach to **all** [emphasis added] EU habitats and species not covered by EU legislation'.

Despite the comprehensive coverage of the NNL objective, this guidance focuses on biodiversity and ecosystems that particularly require conservation measures (e.g. because they are scarce, highly localised, or declining, and/or because they provide critical ecosystem services) but may not be covered by the Birds and Habitats Directives or the Environmental Liability Directive (ELD). In doing this, it supports the Birds and Habitats Directives through encouraging measures that increase the resilience of the Natura 2000 network, such as by reducing external pressures on sites and increasing ecological connectivity across the network, for example, through the maintenance of habitats and features in the landscape (in accordance with Article 10 of the Habitats Directive) and the goals laid out for investments in green infrastructure.

Some aspects of this guidance may be relevant to the ELD[16], which establishes a framework of environmental liability, based on the polluter-pays principle, to prevent and remedy environmental damage. The ELD covers damage to protected habitats and species, which are those listed in Annexes I, II and IV of the Habitats Directives, regulatory occurring migratory birds and other bird taxa listed in Annex I of the Birds Directive, and any other species and habitats designated under national law by Member States. It is effectively a NNL mechanism for these habitats and species with respect to the specific types of damage covered under the ELD. In particular, it requires preventative actions to avoid imminent damage that may threaten the favourable conservation status of a protected habitat or species, primary remediation if such damage occurs to rehabilitate/restore the affected site as much as possible, and complementary and compensatory remediation (i.e. offsetting) of any remaining residual impact on the conservation status of the habitat or species. The principles and practices related to rehabilitation/restoration and offsetting discussed in this guidance therefore may apply to some aspects of the implementation of the ELD. However, this guidance does not provide specific recommendations for the ELD: instead it is recommended that further information and guidance is obtained from the DG Environment ELD webpage[17].

These guidelines also take into account existing relevant guidance on other interacting instruments related to decision-making on plans and projects, in particular the SEA Directive[18] and EIA Directive[19], which also require the application of the mitigation hierarchy and compensation/offsetting of unavoidable impacts on nature and environment.

[16] Directive 2004/35/CE on environmental liability with regard to the prevention and remedying of environmental damage.
[17] http://ec.europa.eu/environment/legal/liability
[18] Directive 2001/42/EC on the evaluation of the effects of certain plans and programmes on the environment.

2 KEY PRINCIPLES AND STRATEGIES FOR ACHIEVING NO NET LOSS OF BIODIVERSITY AND ECOSYSTEM SERVICES

2.1 The need for no net loss objectives and measures

In order to meet the overall EU target of halting the loss of BES, it is clear that more effective and comprehensive efforts need to be taken given the observed recent and continuing declines in BES (EEA, 2010, 2015, 2019; IPBES, 2018). Such actions are particularly required in the wider environment (i.e. outside Natura 2000 sites and other protected areas) and to address impacts on biodiversity components and ecosystem services that are not subject to other strict nature protection measures. Furthermore, many declines are the result of multiple small, scattered developments that nonetheless have substantial incremental and cumulative impacts. However, it is not realistic to prohibit all such activities. To tackle this problem, complementary measures to strict protection are required that have the realistic and proportionate ambition of achieving NNL, rather than no impact. Such NNL objectives can form a key component of sustainable development in that they can help to regulate and manage necessary trade-offs between economic development and the conservation of BES (Quétier, Regnery and Levrel, 2014). NNL approaches also require an explicit frame of reference (Maron *et al.*, 2018) and can be designed and implemented to contribute to achieving biodiversity targets set at a national or sub-national level (Simmonds *et al.*, 2019).

The EU has adopted its NNL policy objective in response to such challenges. However, the following key issues need to be carefully considered when putting the policy into practice, because some interpretations of the NNL objective could potentially have perverse and damaging consequences:

- the mitigation hierarchy of actions leading to NNL;
- the appropriateness of biodiversity and ecosystem service trade-offs;
- the scale over which NNL needs to be measured; and
- the required sectoral coverage.

The following sections set out some key principles that should underpin the development and implementation of any NNL policy framework

2.2 The mitigation hierarchy

A fundamental and universally held principle is that appropriate actions to achieve NNL (or preferably a net gain) should be carried out in the following order of priority in accordance with the mitigation hierarchy:

1. **Avoidance**: measures taken to avoid creating detrimental impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.

[19] Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as amended in 1997 (97/11/EC), 2003 (2003/35/EC) and 2009 (2009/31/EC).

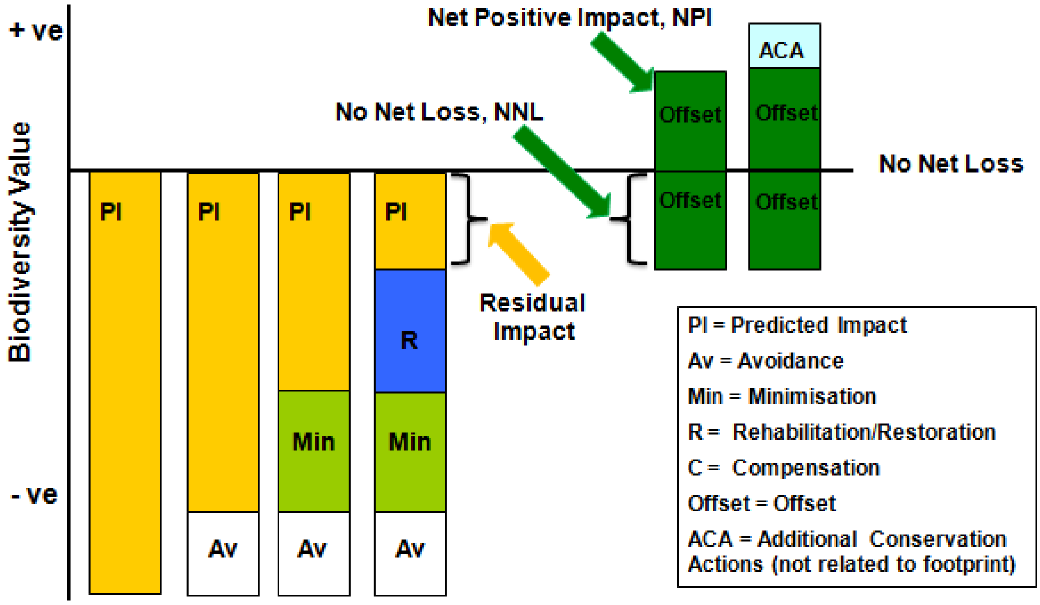
2. **Minimisation**: measures taken to reduce the duration, intensity and/or extent of detrimental impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
3. **Rehabilitation/restoration**: measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimised.
4. **Offset**: measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised (and/or in some cases) rehabilitated or restored, in order to achieve at least NNL of BES.

In other words, emphasis should be given to avoidance of significant adverse impacts at source as the first objective (as well as seeking opportunities to enhance BES). When this is insufficient, it should be followed by measures to reduce or minimise unavoidable impacts. It is only when all the previous appropriate measures of the mitigation hierarchy remain insufficient to avoid negative BES impacts that biodiversity offsetting should be used. As defined by BBOP (2012d), '*Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure and ecosystem function and people's use and cultural values associated with biodiversity*'. Vaissière *et al.* (2020) propose a broader and non-normative definition where biodiversity offsetting is 'the supply of an ecological gain in response to an ecological loss located in a compensation site distinct from the impacted site, following agreed-upon criteria for the ecological equivalence between gains and losses'. Whether or not NNL is achieved depends on the specifics of how equivalence is defined and enforced (Maron *et al.*, 2018).

Offsets are typically carried out by management interventions that enhance, restore, recreate or create ecosystems/habitats that are of equivalent or greater BES value. Offsetting may also in theory be achieved by protecting otherwise threatened habitats – so-called 'averted risk' offsets (Bull *et al.*, 2013). However, their effectiveness and reliability is doubtful (e.g. Ermgassen *et al.*, 2019; Simmonds *et al.*, 2019); and, as discussed in Section 4.3.2, such offsets are not normally recommended in a European context.

Figure 2-1 provides an illustration of how the NNL objective may be achieved, in accordance with the mitigation hierarchy, through the combination of avoidance, minimisation, and rehabilitation/restoration measures followed by offsets for residual impacts. As mentioned above, the latter are only to be considered when the combined results of the previous measures in the mitigation hierarchy remains insufficient to achieve NNL.

Figure 2-1: The achievement of no net loss in relation to the mitigation hierarchy



Source: BBOP[20], adapted from Government of Australia and Rio Tinto.

Whilst there are many demonstrated cases where well designed and properly implemented offsets have achieved NNL or net gains (including in Europe, e.g. Ermgassen *et al.*, 2019, Wende *et al.*, 2018), there is also abundant evidence that they can fail to meet their objectives resulting in BES losses (e.g. Morris *et al.*, 2006; Quigley and Harper, 2006; Ruhl and Salzman, 2006; Gibbons and Lindenmayer, 2007; Walker *et al.*, 2009; Burgin, 2010; Hossler *et al.*, 2011; Quétier and Lavorel, 2011; Suding, 2011; Maron *et al.*, 2012; Gardner *et al.*, 2013; Gordon *et al.*, 2015; Koh, Hahn and Ituarte-Lima, 2017; Lindenmayer *et al.* 2017; Moilanen and Kotiaho, 2018; Wende *et al.*, 2018; Ermgassen *et al.*, 2019; Griffiths *et al.*, 2019). Similar problems can also occur in the rehabilitation/restoration stage of the mitigation hierarchy. Based on such evidence, the most common and significant observed problems with offsets that can lead to uncompensated BES losses, and other undesirable outcomes, include:

- **Practical limitations in accurately and comprehensively measuring** the complex multi-dimensional, context-specific and dynamic values of BES in a practical and transparent way that can ensure the impacts of developments on BES (i.e. debits or losses) and the BES outcomes from offsets (i.e. credits or gains) are reliably and adequately quantified. This leads to uncertainty over whether or not NNL, or other objectives, are achieved. Furthermore this uncertainty is greatly increased if the offsetting impacts are based on predictions rather than activities that have been undertaken (e.g. in established habitat banks), and especially for averted-risk offsets

[20] http://bbop.forest-trends.org/pages/mitigation_hierarchy

based on counterfactual scenarios whose validity can be challenging to demonstrate ex-post.

- **Limitations on the ecological feasibility of rehabilitating, restoring or (re)creating ecosystem and their biodiversity and services**. Some ecosystems are irreplaceable and cannot be restored or re-created – so offsetting for them is never appropriate and they shouldn't be impacted. Except for the very simplest of ecosystems, including some anthropogenic ecosystems widespread in Europe (e.g. Pellegrin *et al.,* 2018), the rehabilitation, restoration or creation of ecosystems and their BES can only be partial, because their biodiversity and services are the result of millions of years of complex biophysical interactions that are not fully understood, measurable or replicable. Therefore, some biodiversity losses and changes in ecosystem services are inevitable when developments result in residual impacts after avoidance and minimisation measures (although gains in some BES elements may occur).
- **Lack of land for offsetting**. Several analyses have shown that achieving NNL through offsetting can require significant amounts of land to be dedicated to restoration and subsequent protection (e.g. Sonter *et al.* 2020), resulting in increased competition for land with knock-on effects on other nature conservation and restoration activities and land-based economic sectors (e.g. farming, forestry) and social impacts (Pech & Etrillard 2016; Calvet *et al.* 2019). This can lead to social and political challenges to offsetting, locally and at other spatial scales as the issue is politicized.
- **Unavoidable spatial impacts.** Complex and obscure ecological impacts may occur as a result of changes in the location, size and connectivity of habitats and their species. Difficulties in ensuring equitable outcomes for people may also occur when biodiversity and ecosystems are offset elsewhere, as many benefits will be lost if their sources are relocated, even over short distances. On the other hand, BES benefits may occur if new offsets are strategically located (e.g. to link up fragmented habitats or to provide recreation areas closer to residential areas).
- **Lack of implementation** of the offset, or non-compliance with design requirements. Whilst such non-implementation problems can occur with any mitigation measures, it may be a particular risk for offsets, as they may often be the most difficult for the developer to carry out in practice (unless they are being provided by a third-party) and particularly costly.
- **Problems with additionality**, i.e. ensuring that offsetting leads to impacts that are additional to those that would have occurred anyway. In this respect offset additionality is particularly difficult to achieve, and measure, when carried out in protected areas. Similarly, it is difficult for habitats, species and ecosystem services that are the focus of restoration targets – although in such cases the offset may at least ensure that the envisaged actions are carried out and their costs are transferred from the public purse to the private sector. On the other hand, crowding out of goodwill and public funding may occur if current investment and spending in conservation or restoration is displaced by the funding opportunities offered by

developers pressured to rapidly find offsetting solutions (e.g. Maron and Louis, 2018).

- **Leakage of benefits,** especially in the case of risk-aversion offsets that protect certain threatened BES (e.g. a scarce habitat), but the underlying threats are not alleviated more widely such that another area is impacted. In other words, risk-aversion offsets may merely displace the impact.
- **Time lags** in the rehabilitation/restoration and offsetting of impacts (which may be hundreds of years for some ecosystems), and therefore temporary BES losses. Some of these may have longer-term knock-on impacts or be irreversible (e.g. if the local population of a species becomes extinct and cannot recolonise unaided).

As a result of these risks, it is very important that the mitigation hierarchy is adhered to (avoidance first). Therefore, concern has been expressed by some (e.g. in the European Commission's NNL consultation) that offsetting policies may be counter-productive by weakening the mitigation hierarchy and becoming a so-called 'licence to trash'. However, evidence that this occurs in European countries appears to be lacking (Tucker *et al.*, 2016). In fact, it is also important to remember that offsetting in the context of this EU guidance relates to weakly protected, or unprotected BES. Therefore, there is little scope for an offsetting policy to weaken protection; most developments would proceed anyway, often leading to uncompensated residual impacts. Furthermore, the development of effective and well-regulated requirements for offsetting implements the polluter-pays principle and should therefore often increase the incentive for activities to avoid and reduce impacts in the first place – thereby supporting the mitigation hierarchy, rather than undermining it (Eftec and IEEP, 2010). On the other hand, it should be recognised that in some circumstances offsetting can have lower costs (or legal risks) than avoidance and mitigation measures; in which case there is an incentive for the developer not to follow the mitigation hierarchy. Therefore, there is a risk that in some circumstances offsetting can could weaken the protection of BES (where it is significant) from damaging activities. For such reasons, offsetting regulations must be properly designed and enforced to prevent this from happening.

The risk of offsetting being counter-productive with respect to protected biodiversity is clearly taken into account in the definition of the NNL concept in the June 2011 Council conclusions, which explicitly notes that measures should not impair existing biodiversity that is 'protected by EU nature legislation'. This is a clear indication that the protection afforded under the Birds and Habitats Directives, including under Articles 6.3 and 6.4, should not be weakened by the NNL initiative. The importance of ensuring consistency with the mitigation hierarchy was also reiterated by the NNL Working Group (NNLWG, 2013a; NNLWG, 2013b), who noted that 'any new proposed policy, aiming to protect and enhance BES, should thus strongly adhere to the mitigation hierarchy, enforcing the recognition that developers and land-users should not be allowed to carry out an activity leading to a loss of biodiversity by simply paying for the damage caused.' They also note that such policy '… must not undermine existing legislation and must in no way legitimise projects that would normally be rejected as a result of measures in existing environmental legislation'.

It is important to note that actions within the mitigation hierarchy **must be appropriate**, and therefore in some cases it may be justifiable to undertake offsetting rather than carrying out feasible avoidance or mitigation actions if this results in a better and more reliable biodiversity outcome. For example, in some cases, avoidance or reduction measures may not be as reliable or as effective as offsetting measures. This is not to say that the mitigation hierarchy should not be followed, just that in some cases avoidance or reduction measures may not be feasible or effective and therefore residual impacts will occur that need to be compensated for. For example, evidence of beneficial population-level impacts of some commonly used mitigation measures, such as the use of 'green' bridges over roads and railways to mitigate habitat fragmentation (Iuell *et al.*, 2003), is often lacking (Clevenger and Wierzchowski, 2006; Mazza *et al.*, 2012; Van der Ree *et al.* 2015). Such uncertainty needs to be taken into account in the calculation of residual impacts. In other words, in accordance with the precautionary principle, claimed reductions in impacts resulting from mitigation measures need to be supported by reasonable proof before they are taken into account when calculating residual impacts.

Consequently, to ensure the mitigation hierarchy is adhered to in practice it needs to be applied with careful thought, and often iteratively to some extent, but always with adequate scrutiny by environmental authorities and in a transparent manner that also allows scrutiny by stakeholders. Where it is claimed that adverse impacts cannot be avoided, convincing reasons for such unavoidability should be provided.

2.3 The appropriateness of biodiversity and ecosystem service trade-offs

An important consideration concerns potential trade-offs between different types of biodiversity or ecosystem services. A weak interpretation of sustainability could treat unprotected biodiversity and ecosystem services as exchangeable commodities, with losses deemed acceptable as long as they are adequately compensated for by another service and/or elsewhere. If the requirement for NNL is defined in these terms, then it could allow potentially significant trade-offs (Jacob *et al.* 2016; Sonter *et al.* 2019). However, **an exchange of biodiversity losses for gains in ecosystem services or wide exchange of biodiversity components would not be appropriate because it would conflict with current international and EU nature conservation aims and principles**, which clearly intend to maintain the range and populations of all native species and habitats. Such aims are also consistent with the concept of achieving strong sustainability (Quétier, Regnery and Levrel, 2014). Thus, to be consistent with higher EU biodiversity goals, in principle the NNL objectives need to relate to individual habitats and species that are considered to be of sufficient importance to be the subject of NNL objectives (see Section 4.2). Therefore, where offsets are required, the appropriate default position should be that impacts on one species or habitat are offset by equivalent gains in the same species or habitat – i.e. 'like-for-like' (also sometimes known as in-kind offsets)(Masyek *et al.*, 2016). The establishment of habitat banks (as discussed in Section 4.5.3) can help to provide such like-for-like offsets.

It is important to note, however, that in some circumstances where habitats or species of less biodiversity importance are concerned it is more appropriate for offsets to be intentionally applied to other habitats or species when they are considered to be of higher biodiversity importance and/or at greater overall risk of declines. Such 'trading up' should aim to ensure at least an equivalent biodiversity gain as would have occurred if the compensation was for the impacted habitat type or species. This approach allows offsetting resources to increase their efficiency and added value by focusing on species and habitats of high value that are subject to widespread impacts and undergoing overall declines. Further discussion of the principles and methods of measuring and ensuring assessing biodiversity and trading-up rules is provided in Section 4.3.

Similar considerations apply to ecosystem services, as there is a choice over whether there should be NNL for each ecosystem service, for various groups of services or for them overall. As for biodiversity setting NNL objectives for combined ecosystem services would risk inappropriate trade-offs, because each service provides different types of benefit, and often to different beneficiaries. For example, it would be inappropriate to balance losses in cultural services with gains in provisioning services such as timber provision, or regulating services such as carbon storage. Therefore, in principle one should define NNL for each service, but this would normally be impossible to achieve as ecosystems usually provide too many services to assess in practice and some trade-offs amongst services are nearly always inevitable. Therefore, it is normally appropriate to identify and set objectives for the most important ecosystem services individually, which will need to be done on a case-by-case basis as their value and replaceablility is generally context specific (Griffiths *et al.* 2019). Consequently, the concept of trading up is not normally applicable to achieving NNL of ecosystem services.

Lastly, it is important to carefully consider interactions between biodiversity objectives and ecosystem service delivery and requirements, and then to attempt to minimise trade-offs and enhance synergies in NNL measures, such as offsetting as further described in Section 4.2.1. However, this can be difficult as literature is scarce on these topics (Sonter *et al.*, 2019).

2.4 The appropriate scale of measuring no net loss

A further fundamental consideration in the design of NNL policy measures is the scale over which NNL should be set and assessed. In theory, NNL objectives can be set at a project, plan, programme or policy level, and at different spatial scales: for example, local/city level, region, river basin, country or EU level. Some authors have discussed what a global NNL target could be (Maron *et al.* 2019).

With respect to biodiversity, NNL objectives should in principle relate to the smallest local scale feasible in order to contribute to the headline target of halting the loss of biodiversity. This is because habitats differ in their composition and other characteristics over their range, and species will differ in their genetic make-up. Consequently, current EU nature conservation objectives and legislation aim at the very least to maintain habitats and species populations within their existing range, and to maintain the extent of their range. Thus, losses of habitats and species in any location, even if balanced by gains elsewhere may result in overall biodiversity losses. Furthermore, as discussed below, habitats and species underpin ecosystems services that are often location-specific and therefore these losses often need to be replaced in situ.

Thus, where biodiversity offsets are required to address residual impacts they should in principle be implemented locally, where this is ecologically appropriate and practical. Setting a local NNL objective is consistent with the European Commission's guidance on compensatory measures for impacts on Natura 2000 sites (European Commission, 2000, 2007), which states that locating the compensation within, or as close to, the affected Natura site is the preferred option.

However, because habitats and their biodiversity in much of the EU are already degraded and often isolated and fragmented, in practice it may be appropriate for offsetting to occur at greater distances from the impacted area, and thus NNL achieved over a larger scale. Simplistic offsetting rules that require offsetting measures to be carried out on-site, or adjacent to it if possible, may not lead to the best biodiversity outcomes. This is because in some situations it can lead to ineffective compensation, for instance through the restoration/creation of poor quality, fragmented or disturbed habitats. As noted in the Commission's guidance on Natura 2000 compensation, the overall aim should be to maximise the benefits with respect to the overall coherence of the network. Therefore, it may sometimes be better to implement the offsetting in a more suitable but ecologically appropriate off-site location (e.g. ensuring it is functionally connected to existing wider viable populations) where, for example, the viability of the habitat may be greater and it may contribute to restoring habitat connectivity. Thus, the optimal location of offsets is not always straightforward, and needs to be carefully considered.

The appropriate location and scale of the NNL objective becomes even more complex when considering ecosystem services, because their needs vary according to their location and context, except with respect to carbon sequestration and storage, for which there is a global level requirement (Burkhard *et al.*, 2014). For non-carbon-related ecosystem services, it is most appropriate to set ecosystem service NNL objectives through an approach that considers the local needs for each ecosystem service, in order to ensure that the human benefits of the services are maintained in an equitable way. In other words, for ecosystem services it is necessary to ensure NNL of supply and benefit, which is achieved by ensuring they are retained or offset in areas where supply intersects demand (Sonter *et al.*, 2019). For example, if a project results in a reduction of water storage capacity this should be offset if the service needs to be maintained because it is already in short supply, or might become so in the foreseeable future. In this situation the appropriate location and scale for achieving NNL would be the catchment in question.

2.5 Year for baseline

To evaluate NNL, it is essential to decide on the baseline or reference situation with respect to time. For example, the baseline could be set as the pristine original biodiversity that was present, but in many cases this is not realistic. NNL most likely will be evaluated for the biodiversity that will be affected by the planned project development when permits are sought. In other cases, the biodiversity baseline is the biodiversity that would be present if the project development did not occur, over time. The use of such counterfactual scenarios can, however, entrench background rates of biodiversity loss (Maron *et al.*, 2018). Alternatively, a plan or project or prevailing legislation can set a higher ambition level, e.g. in aiming to achieve restoration targets within a landscape or for certain species. With respect to prevailing legislation, the argument could be made that the baseline across Europe be set at the date of implementation of the Habitats Directive in 1994.

2.6 Sectoral coverage

Measures that aim to achieve NNL (such as offsetting) tend to be aimed towards the treatment of residual impacts from built developments and extractive industries, and so on, partly because of the practicalities involved. Agriculture, forestry, fishing and other land and sea uses are sometimes explicitly excluded, as, for example, under specified detailed requirements related to the Mitigation Regulation in Germany. However, a wide range of pressures are leading to biodiversity declines, among the most important of which are those associated with agriculture, forestry and fisheries (EEA, 2010, 2015). Therefore, if NNL is actually to be achieved in the EU then NNL policy measures need to include these three sectors as well as all other human activities that have significant impacts on BES.

A similar conclusion was drawn in a Commission study on policy options for the achievement of NNL (Tucker *et al.*, 2014) and by the majority of the members of the NNL Working Group. The final version (12 July 2013) of the Group's document describing the scope and objectives of the NNL initiative noted from the industrial sectors that 'it might be argued that a NNL initiative which targets development impacts but not the impacts of agriculture and fisheries is not treating all sectors equitably' (NNLWG, 2013a). A strong rationale is therefore required for not including these in the NNL initiative. A majority of working group participants argued that there is no such strong rationale and that the impacts of agriculture, forestry, fisheries and alien species, should be included within the initiative. It is also important to note that agriculture, forestry, and fisheries can benefit from NNL, as shown by new business models for farmers maintaining offset areas (Wende *et al.*, 2018; Calvet *et al.* 2019).

While it is outside the scope of this document to set out guidance on achieving NNL for all sectors, some initial proposals for reducing BES impacts and options for achieving NNL in agricultural systems at the regional or national level through policy measures are set out in the Commission's NNL policy options report (Tucker *et al.*, 2014). It is noteworthy that greening measures under the Common Agricultural Policy (CAP) that require the ratio of permanent grassland to be maintained, at a national or regional level, are a form of NNL policy measure. Evidence suggests that this is contributing to the maintenance of the total area of permanent grassland, although the effectiveness of the measure varies among the EU Member States, depending on its scale of measurement and degree of enforcement (Alliance Environnement and Thünen-Institut, 2017). However, its effectiveness at maintaining BES is very limited, as permanent grassland is defined in such a way that it can be regularly ploughed up (which severely degrades its BES value). Thus, in practice the measure does not make a significant contribution to achieving BES NNL on most permanent grasslands (although other grasslands of higher environmental sensitivity are given strict protection).

It is also relevant that less attention has been given as to how to deal with NNL and biodiversity offsetting in marine environments (Niner *et al.*, 2017; Shumway *et al.* 2018; Jacob *et al.* 2020). With projections that the 'ocean economy' will more than double between 2010 and 2030, it follows that biodiversity offsets are likely being increasingly applied offshore (EC Blue Growth, 2012; OECD, 2016; UNEP-WCMC, 2016). Indications are that the challenges posed by the use of biodiversity offsetting policies in the marine environment are common to those faced in terrestrial applications (UNEP-WCMC, 2016). The marine environment, however, presents unique difficulties, including the high level of uncertainty within marine impact assessment owing to: (1) the highly variable and connected nature of the environment; (2) the limited evidence of ecological restoration success in a marine context; and (3) the diffuse, complicated and at times remote governance arrangements managing the resource (reviewed in Niner *et al.*, 2017).

2.7 Mainstreaming biodiversity and ecosystem service objectives into policies and programmes

Give the sectoral coverage requirements, a fundamental prerequisite for the achievement of BES NNL is the clear incorporation (i.e. mainstreaming) of such objectives into all socio-economic development policies, programmes and major projects. In this context, it is important to highlight the recently published EU Guidance document on ecosystems and their services in decision-making, which outlines the wide range of benefits that flow from nature, and possible ways to take better account of these benefits in policy, planning and business investment decisions[21]. This also supports broader sustainable development goals and the requirement for environmental policy integration, which is established under the primary law of the EU[22]. EU case law has already established this so-called integration principle as a binding principle. The Lisbon Treaty on the Functioning of the EU also gives legally binding force to the Charter of Fundamental Rights of the EU, which requires that a high level of environmental protection and improvement of the quality of the environment must be integrated into EU policies (Article 37).

The principle of environmental policy integration also builds on the principle of policy coherence, which is about ensuring that policies are coordinated and should not contradict

[21] https://ec.europa.eu/environment/nature/ecosystems/index_en.htm

[22] The Lisbon Treaty on the Functioning of the EU states in Article 11 that 'environmental protection requirements must be integrated into the definition and implementation of all Union policies and activities, in particular with a view to promoting sustainable development.'

each other. Although full coherence between policies is unrealistic (as every policy is guided by legitimate objectives, which can be contradictory at times) policies should as a minimum avoid major conflicts of interest between them (OECD, 2008). Moreover, policies are required to increase their synergies and hence reinforce their effects.

When BES goals are mainstreamed, they drive subsequent measures, creating clarity over what is required and the justification for regulations and supporting measures such as financial incentives, guidance, and stakeholder engagement. However, to be effective BES mainstreaming needs to be based on clear SMART objectives (i.e. specific, measurable, achievable, relevant and time specific) that should have NNL as a specific explicit minimum objective (while recognising the mitigation hierarchy), but where feasible consider synergies to enhance BES (i.e. to achieve 'net gain'). For example, regional economic development plans many provide many opportunities to enhance the environment, such as through the restoration of degraded ecosystems (e.g. tackling air and water pollution), which may in turn provide substantial and varied BES benefits. This is, for example, recognised in the Wales Environment Act 2016, which requires that plans and projects should aim to enhance the resilience of ecosystems and the benefits they provide[23].

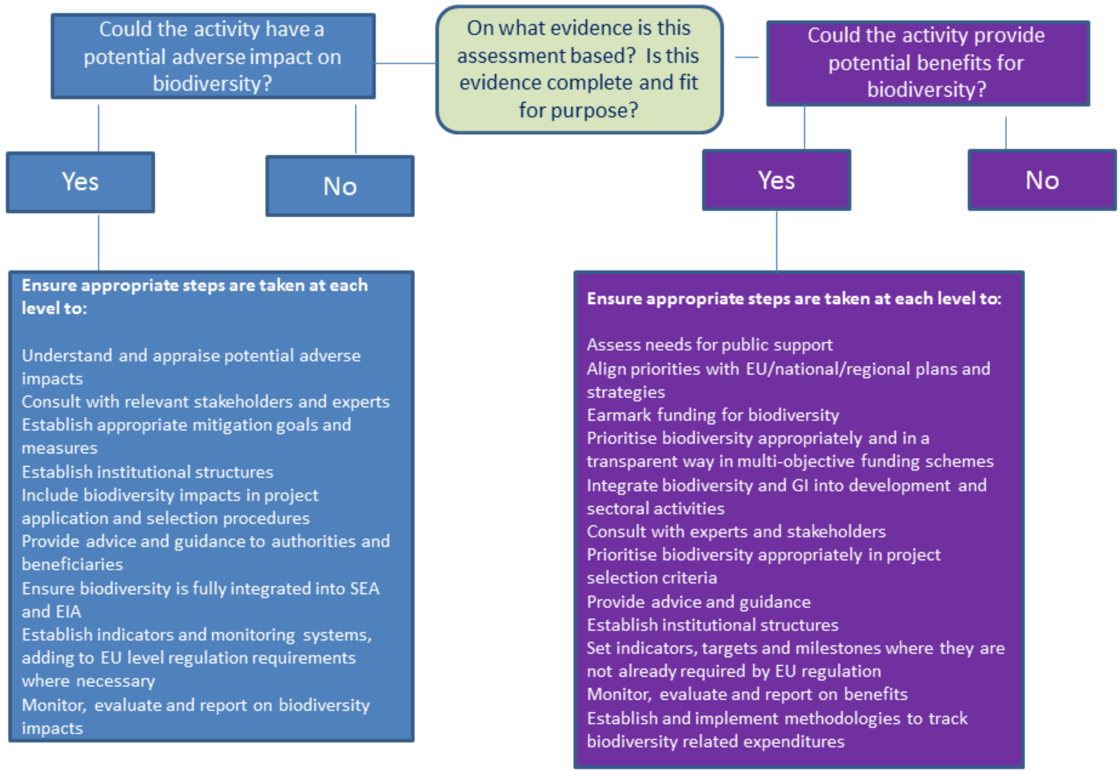
An important and practical conceptual framework for supporting the mainstreaming of biodiversity into policies and programmes, which can also be applied to ecosystem services, is that of **biodiversity proofing.** This has been developed and defined by the European Commission as **'**a structured process of ensuring the effective application of tools to avoid or at least minimize harmful impacts of EU spending and to maximise the biodiversity benefits. It applies to all spending streams under the EU budget, across the whole budgetary cycle and at all levels of governance, and should contribute to a significant improvement in the state of biodiversity according to the 2010 baseline and agreed biodiversity targets' (IEEP, GHK and TEPR, 2012; Medarova-Bergstrom *et al.*, 2014). Biodiversity proofing facilitates policy integration and the ability for all EU funds to contribute to the achievement of the EU's biodiversity target, by mainstreaming biodiversity considerations into decision-making processes. Specifically, it aims to ensure that, at each stage of the policy and project cycles, decision-makers make sure that:

1. **potential adverse impacts on biodiversity** are considered, identified, quantified and communicated, that appropriate actions are taken to avoid and minimise them, and then, where necessary, to compensate for unavoidable residual impacts in order to achieve no net loss; and
2. **opportunities for activities to benefit biodiversity** are identified and taken forward.

Figure 2-2 outlines a general approach to biodiversity proofing that illustrates the key questions that need to be examined when assessing biodiversity impacts and opportunities in the context of reaching NNL or NG.

[23] http://www.legislation.gov.uk/anaw/2016/3/contents/enacted

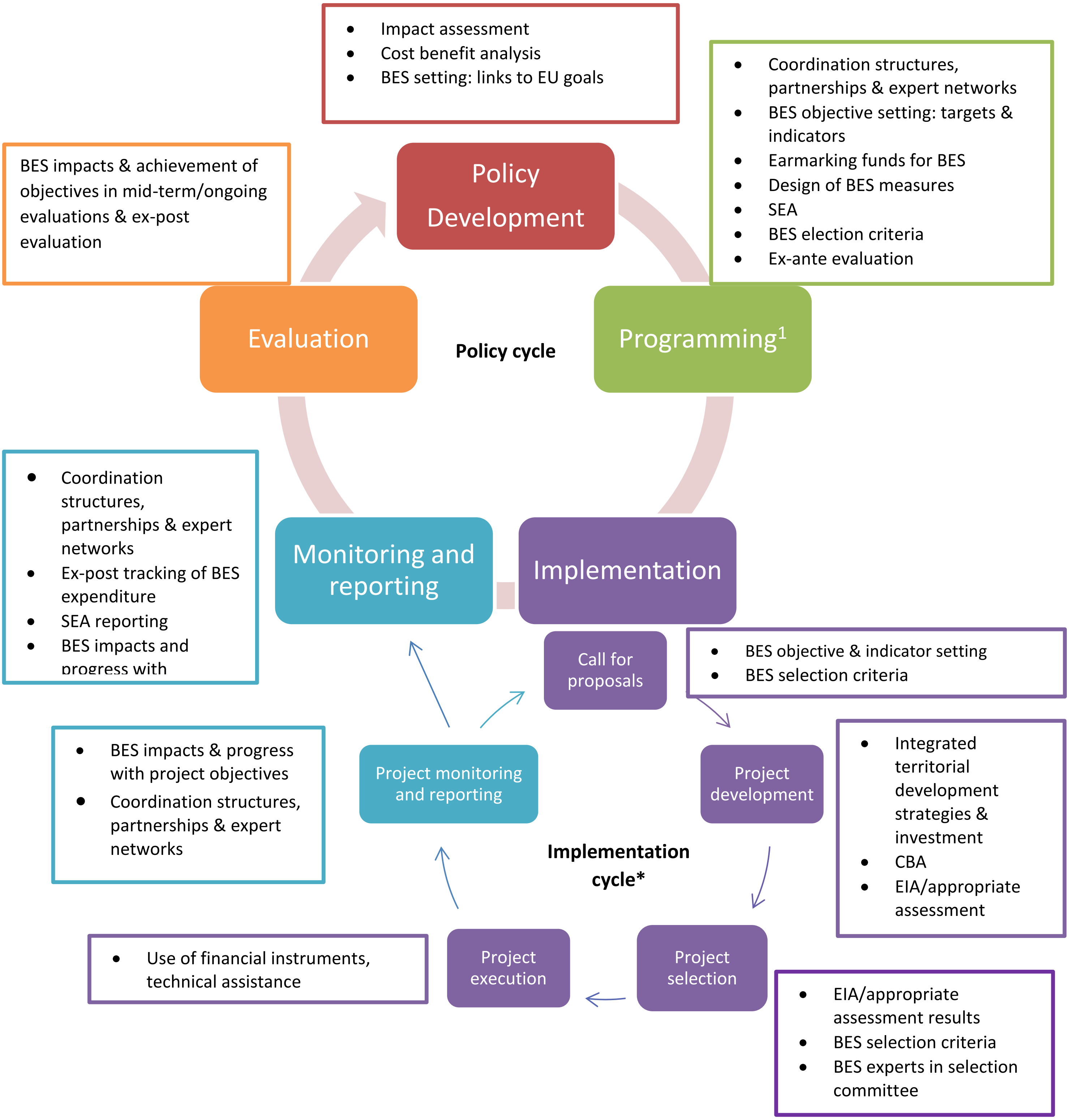
Figure 2-2: Key questions to be considered in biodiversity proofing



To promote biodiversity proofing, and increase policy coherence and consistency, the European Commission has developed a Common Framework for Biodiversity Proofing that represents a standardised approach that can be applied to most EU funds by national and regional authorities in Member States. To help authorities in charge of programmes and funds relevant to biodiversity proofing, it indicates the various proofing tools that can be used at each step and their respective strengths and complementarities. The approach can also be adapted and applied to non-EU policy initiatives, programmes and funding mechanisms.

The Common Framework (Figure 2-3), comprises two interacting cycles: the policy cycle and the implementation cycle. The **policy cycle** takes place at a high strategic level and concerns the alignment of EU strategies with the EU Multi-annual Framework (MFF) and related fund-specific Regulations. In this cycle the programming stages provide a number of biodiversity proofing opportunities, the most relevant being biodiversity objective and indicator setting, earmarking of funds for biodiversity, design of biodiversity measures, integrating biodiversity considerations in the programmes' ex-ante evaluation, and related SEA procedures (see Section 3.2). These and other proofing tools/procedures may be supported by establishing coordination structures, partnerships and expert/information networks that manage biodiversity programmes or projects but also coordinate actions across sectoral departments, work exclusively with beneficiaries, or cooperate with networks of environmental/climate experts.

Figure 2-3: The Common Framework for Biodiversity Proofing with key tools that may be used at each intervention stage – adapted for biodiversity and ecosystem services (BES)



Notes: 1. For ESI funds, this includes the development of Partnership Agreements followed by RDPs for the EARDF, Operational Programmes for the ERDF, ESF and Cohesion Fund, and Fishery Programmes for the EMFF. Only includes Work Programmes for the CEF.
* The full project cycle applies to major investments in particular, and is likely to be significantly simplified for small grants.

Of greater relevance to this current guidance on achieving NNL is biodiversity proofing in relation to the **implementation cycle** of EU Work Programmes for the Connecting Europe Facility (CEF) for energy and transport, the Partnership Agreements and the Operational Programmes for Cohesion Funds (i.e. European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund), the Rural Development Programmes for the European Agriculture Fund for Rural Development (EAFRD), and the European Maritime and Fisheries Fund (EMFF) under the European Common Fisheries and Integrated Maritime Polices. Implementation of these funds is through projects that are typically carried out in five cyclic stages, which provide opportunities for biodiversity considerations to be taken into account.

At the initial **call for proposals,** important proofing tools in which ensure biodiversity is considered from the onset include setting out minimum biodiversity requirements and desired objectives, and incorporating them into project selection criteria and scoring systems. The aim at this stage is to discourage project proposals that may have detrimental impacts and to encourage biodiversity-positive projects.

Project development occurs in response to the call for proposals, and this is likely to involve some form of cost-benefit analysis. This provides an important opportunity to take ecosystem services into account when identifying all relevant costs and benefits relating to changes in BES. When project proposals are then further developed some form of EIA may be carried out, in accordance with requirements under the EIA Directive for many EU-funded projects (see Section 3.3).

At the **project selection** stage, the biodiversity criteria and scoring systems can be included in the call for proposals and used to evaluate proposed projects. In addition, the adequacy, feasibility and reliability of proposed mitigation measures, and, where necessary, offsets for residual impacts (normally set out in an EIA) should also be taken into account; taking particular care to ensure that the mitigation hierarchy is followed.

Opportunities for biodiversity proofing interventions remain during the **project execution** stage, for example through technical assistance.

Finally, the **project monitoring and reporting** stage provides an opportunity to track progress against identified objectives (e.g. biodiversity-positive spending, and biodiversity impact indicators), including those identified in the policy cycle programming stage and those identified in the call for project proposals and project development stage. The results can then be fed back into the calls for proposals, so that future calls and objectives can be adjusted as necessary to better address biodiversity-related opportunities and impacts.

The monitoring results from each project should then inform the **policy cycle** by being fed back into the overall **monitoring and reporting** of biodiversity-positive expenditure at the level of work/spending programmes. This in turn informs final policy **evaluations** (which may include both ongoing/mid-term evaluations as well as an ex-post evaluation), the purpose of which is to assess the effectiveness and efficiency of EU funding instruments. The evaluation should then feed back to the **policy development** stage, ensuring that lessons learnt and good practices are incorporated into the next policy cycle.

Guidance on the Common Framework for Biodiversity Proofing and related proofing tools has been developed by the Commission, together with more detailed fund-specific guidance, available on the biodiversity proofing page of the DG Environment website[24]. While the development of the Common Framework and guidance on biodiversity proofing has focused on biodiversity, it can also be applied to ecosystem services, especially if linked to MAES and related initiatives, and then incorporated into spatial plans, SEA and EIA.

2.8 Stakeholder involvement

Effective participation is critical to both the success and fairness of NNL approaches and biodiversity offsets. It is in this context that BBOP developed guidance specifically addressing the involvement of stakeholders (BBOP, 2009). The guidance discusses the principles behind an inclusive and participative approach to the design and implementation of biodiversity offsets, the benefits that such an approach can bring, and the challenges that must be addressed by the project proponent. It also covers some of the key issues that a participation process should address, including identifying and involving stakeholders, understanding land rights and resource use practices, introducing sustainable use practices, promoting equity and handling conflict, and ensuring long-term sustainability of the offset.

[24] http://ec.europa.eu/environment/nature/biodiversity/comm2006/proofing.htm

3 GUIDANCE ON AVOIDING AND MINIMISING IMPACTS

3.1 Spatial planning

Spatial planning aims to create a rational territorial organisation of land use and appropriate linkages between uses, to balance demands for development with the need to protect the environment and to achieve social and economic objectives. It can be carried out at any scale, from the supranational to the national, regional or local. The process allows for more informed and rational selection of development sites and for more efficient use of space and resources (Gilliland and Laffoley, 2008). Best practice spatial planning uses an ecosystem approach to develop a multi-sector strategy that balances and achieves environmental, economic and social objectives. In an ideal scenario, spatial plans provide the environmental baseline and framework, including biodiversity targets, for SEAs of spatial developments such as transport plans, and EIAs for projects and developments. Spatial plans must themselves be subject to an SEA.

Spatial planning can contribute to BES objectives by integrating all the issues that affect the development and use of land within a specific territorial area, as well as considering strategic issues that may affect a wider area than the individual plan (Almenar *et al.*, 2018; Rozas-Vásquez *et al.*, 2018). Public consultation is a key feature in spatial planning and in environmental assessment procedures. This allows for the public and key stakeholders to be involved during the entire process, including when discussing BES impacts and how to reach NNL. Plans should set out a clear vision for how the natural environment can be enhanced and how to ensure that social and economic development takes place within environmental limits. Setting quantitative and time-bound biodiversity targets can help achieve this vision and inform the design and sizing of mitigation and offsetting requirements for plans, programmes and projects. Spatial planning therefore has considerable potential to contribute to the avoidance and minimisation of BES impacts, as well as potentially facilitating net gain through, for example, identifying target areas for ecosystem restoration, green infrastructure and offsetting (Almenar *et al.*, 2019; Grimm, Köppel and Geißler, 2019; Tulloch *et al.*, 2019; Gaucherand *et al.*, 2020).

The approach to **terrestrial spatial planning** varies greatly between and within Member States. Each Member State has its own legal framework and spatial plans at national, regional and local scales. However, only a few regions in the EU currently develop large-scale terrestrial spatial plans that identify desired land uses with respect to environmental, social and economic needs. Moreover, not all Member States explicitly address biodiversity in spatial planning (i.e. identifying areas of land with different levels of biodiversity importance and protection to achieve biodiversity objectives; see also Hersperger *et al.* 2020). Where there is obligatory biodiversity compensation and offsetting, for example in Germany or France, spatial planning is an important tool for reserving and optimising biodiversity offset areas (see Section 4.5).

Marine spatial planning (MSP) presents significant opportunities for large-scale systematic planning for BES objectives. More broadly, MSP works across borders and sectors to ensure human activities at sea take place in an efficient, safe and sustainable way. Specifically, the Maritime Spatial Planning Directive[25] obliges coastal Member States to establish and implement MSP using an ecosystem-based approach to analyse and organise human activities in marine areas to achieve ecological, economic and social objectives. MSP helps public authorities and stakeholders coordinate their activity and optimise the use of marine space to benefit both economic development and the marine environment, including nature and species conservation sites and protected areas. In most Member States[26], local or regional authorities are responsible for maritime and coastal planning up to 12 nautical miles from the shore, while national authorities are responsible for planning in their exclusive economic zone (EEZ). Terrestrial spatial planning should be coordinated with MSP as land-based activities such as agriculture and urban growth can impact the marine environment.

Although the EU has limited competency over spatial planning issues, a number of initiatives have been carried out to promote good practice spatial planning, including in relation to biodiversity. These include a Commission study on Natura 2000 and spatial planning (Simeonova *et al.*, 2017), which outlined the following recommendations to achieve an integrated spatial planning approach to help meet the objectives of Natura 2000:

- Spatial planning should be recognised as one of the key elements for effective implementation of Natura 2000 policy.
- Authorities at different levels of planning (national, regional and local) should tap into opportunities for joint implementation of spatial-planning policies to reduce costs and increase the effects of different sectoral policies.
- Policymakers and practitioners should consider the potential opportunities offered by EU funds to improve and promote integrated spatial planning practices for Natura 2000.
- The potential of spatial planning for EU initiatives such as NNL should be studied and communicated among relevant actors in the Member States.
- Governments should continue their efforts to involve more citizens in spatial planning, particularly in the early stages of plan development.
- Cross-border cooperation on spatial planning should be promoted to enhance the coherence of the Natura 2000 network across borders.
- New relevant GIS-technologies should be systematically scrutinised to assess their potential for spatial planning and Natura 2000.
- More efforts should be made by the Member States and related EU initiatives to further raise awareness on the role of spatial planning for nature policy, in particular through sharing and promoting examples of best practices.

[25] Directive 2014/89/EU establishing a framework for maritime spatial planning.
[26] For example, UK (England) is an exception, as the Marine Management Organisation (MMO) has been delegated responsibility for all coastal and maritime planning.

Other examples of guidance relating to spatial planning and BES are included in Box 3-1**:**. Guidance and case studies relating to spatial planning and wind energy developments and extractive industries are available on the DG environment website[27]. The Commission's guidance on incorporating ecosystem services into decision-making provides an example of how ecosystem service mapping and assessment was used to support urban planning in Trento, Italy (European Commission, 2019a, Box 16). Further discussion of spatial planning and offsetting, and some good practice examples are included in Section 4.5 of this guidance.

Box 3-1: Guidance on spatial planning in relation to biodiversity and ecosystem services

CEMAT (2000) *Guiding Principles for Sustainable Spatial Development of the European Continent*.

Commission for Environmental Assessment (2006) *Biodiversity in EIA and SEA. Background Document to CBD Decision VIII/28: Voluntary Guidelines on Bio-diversity Impact Assessment*. https://www.cbd.int/doc/publications/imp-bio-eia-and-sea.pdf

DREAL PACA (2017) *PLU(i) et biodiversité - Concilier nature et aménagement*. Direction régionale de l'Environnement, de l'Aménagement et du Logement de la région Provence - Alpes - Côte d'Azur. Marseille. (in French) http://www.paca.developpement-durable.gouv.fr/IMG/pdf/guideplu_biodov_052017_vdef.pdf

Gilliland, P., and Laffoley, D. (2008) Key Elements and Steps in the Process of Developing Ecosystem-based Marine Spatial Planning. *Marine Policy,* 32(5), 9.

RSPB, the Chartered Institute of Ecology and Environmental Management, and the Royal Town Planning Institute (2013) *Planning Naturally. Spatial Planning with Nature in Mind: in the UK and beyond.* Strategic Environmental Assessment.

Simeonva *et al.* (2017) *Natura 2000 and Spatial Planning*. Final Report for the European Commission.

The consideration of BES in spatial planning, SEA and EIA requires a range of data to address questions about the area covered by the plan or the possible impact zone of the proposed development (European Commission, 2013, 2019a; Gullison *et al.*, 2015; McGuinn *et al.*, 2013). However, SEAs and EIAs are often found to be of insufficient quality because of the lack of environmental data, including biodiversity data, and/or inadequate use of existing data (COWI, 2009).

Data useful for biodiversity mapping include land cover maps, habitat and biotope distribution data that can be presented as a map, metadata or the raw data as a download, species distribution maps, location of protected areas, and other environmental data that directly relate to relevant pressures on biodiversity. Key biodiversity data required to support effective and efficient spatial planning and impact assessments are listed in

[27] http://ec.europa.eu/environment/nature/info/pubs/directives_en.htm

Table **3-1**. Required ecosystem service data for incorporation into spatial planning will vary considerably depending on the services under consideration and their scale and context, and could therefore involve a wide range of biophysical maps and models of ecosystem services, and assessments of their social and economic values. Guidance on such sources of information and analytical tools (e.g. ESMERALDA, and the Values database) are provided in European Commission (2019a). Some key reference data and sources for ecosystem mapping are also listed on the MAES website[28].

Table 3-1: Types of biodiversity and ecosystem service data that may be required for spatial plans, SEA and EIA

Type of biodiversity data	Format of data	Relevance to spatial planning, SEA & EIA
Species distribution map (sometimes combined with relative abundance)	GIS maps of actual occurrence and/or modelled distributions: - grid-based data (pixel, raster, km2) - polygon data (shape files) - average frequency of occurence within specific geographic units, e.g. regions or countries	Location of species of conservation concern in relation to planned development Migration pathways
Species occurrence records	Individual occurrence records (point data) Occurrence within a patch (plot, region, etc.) Sampling records (occurrence of all species in an area)	Location of species of conservation concern in relation to planned development
Species abundance	Numbers of individuals during breeding/migration/wintering season at local, regional or national level	Baseline of species abundance and distribution before development Insights into opportunities for enhancing abundance through restoration
Species threat status	Global, regional (e.g. European) and national Red List status and other national and local conservation status assessments/lists (e.g. in National Biodiversity Action Plans)	Prioritisation of possibly affected species according to threat status
Species abundance trend	Trend (time series) calculated from repeated sampling-event data	Baseline of species population trend before development
Species behaviour/trait	Individual scientific studies and reviews of findings Trait data extracted from datasets, e.g. fish catch data May be single observance/experiment or time series	Possible impact of particular activity on species, cumulative impact of several activities Insights on the possible effects of timing of construction or operations

[28] https://biodiversity.europa.eu/maes/mapping-ecosystems/reference-data-for-ecosystem-mapping

Type of biodiversity data	Format of data	Relevance to spatial planning, SEA & EIA
Habitat and vegetation maps	Survey data – maps and spatially specific survey findings according to a classification system	Location and identity of habitats within development area providing contextual and baseline information data for species occurrence maps or models Insights into restoration potential habitat connectivity and opportunties for enhancement
Community composition	Species richness and/or presence of characteristic species	Provides baseline data and an indication of conservation value
Ecosystem functions	Qualitative or quantitative information on soil, air and water functions, e.g. cold air flows, soil erosion, soil compaction, groundwater flows	Environmental status of development area
Species genetic composition	Allelic diversity	An appropriate assessment should evaluate the conservation status of rare species, which may include their genetic composition, but not required for SEA or EIA.
Ecosystem services	Maps of ecosystem services (supply and demand), and assessments of their values. An example from Flanders is the 'Nature Value Explorer' ('Natuurwaardeverkenner')[29]	Baseline spatial and quantitative information on ecosystem services and their values

It is now being increasingly recognised that a lack of up-to-date and reliable BES data can result in environmental conflicts that may delay or halt development projects, resulting in costs that often far exceed the cost of strategic, proactive data collation. One such example, affecting a major windfarm development, is outlined in **Box 3-2:**. Therefore, some Member States have developed national portals to aid policymakers and consultants with spatial planning, EIA and SEA. For example, the Danish Natural Environment Portal, the UK National Biodiversity Network, and France's Géoportail[30] provide access to large collections of datasets on biodiversity and the environment. Internationally, data on species and protected areas are accessible through the Integrated Biodiversity Assessment Tool (IBAT)[31].

[29] https://www.natuurwaardeverkenner.be
[30] https://www.geoportail.gouv.fr
[31] https://ibat-alliance.org

Box 3-2: Example of development problems resulting from inadequate biodiversity data being used in an SEA

Spatial plans based on poor and limited biodiversity data will hinder the scope of SEAs and EIAs. One example was the SEA carried out for the London Array wind farm in the UK, which was found to have underestimated the potential impacts on Red-throated Divers (*Gavia stellata*) and Little Auks (*Alle alle*). A programme of digital aerial surveys of the birds within the outer Thames estuary and, modelling using all available data from the pre-construction, construction and post-construction periods for the London Array found significant population density declines in the proximity of the turbines (APEM Ltd, 2015). As a result, the planned second phase expansion to a further 39 km^2 and estimated 56 new turbines was cancelled at a relatively late stage in the planning.

3.2 Strategic Environmental Assessment

SEA is a particularly important tool for identifying and then avoiding or minimising environmental impacts early in the development cycle. It is a legal requirement under the SEA Directive[32] for a wide range of public plans and programmes[33] relating to activities such as land use, transport, energy, waste and agriculture. The SEA Directive aims to ensure that such plans and programmes that are likely to have significant effects on the environment are subject to an environmental assessment, prior to their approval or authorisation. These include those prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use, and which set the framework for future development consent of projects listed in Annexes I and II of the EIA Directive, or which, in view of the likely effect on Natura 2000 sites, have been determined to require an assessment pursuant to Article 6 or 7 of the Habitats Directive. SEA is also a formal requirement in the ex-ante evaluation of European Structural and Investment (ESI) funds[34].

SEA, EIA and appropriate assessments as required under the Habitats Directive[35] interact and complement each other, as indicated in

[32] Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment.

[33] The Directive defines 'plans and programmes' as those which are subject to preparation and/or adoption by an authority at national, regional or local level or which are prepared by an authority for adoption, through a legislative procedure by Parliament or Government, and which are required by legislative, regulatory or administrative provisions.

[34] I.e. the EAFRD (under the CAP), ERDF, ESF, CF (under Cohesion Policy), and EMFF, which are also called the European Structural and Investment (ESI) funds.

[35] The Habitats Directive Article 6(3) requires plans or projects which are likely to have a significant effect on a Natura 2000 site to undergo an 'appropriate assessment' and should be approved only after it is ascertained that they will not adversely affect the integrity of the site concerned. Article 6(4) includes provisions that allow projects or plans that may have adverse impacts to go ahead if they are of overriding public interest and there are no alternative solutions. In such cases the Member State 'shall take all compensatory measures necessary to ensure that the overall coherence of the Natura 2000 Network is protected'.

Table 3-2. In particular, as SEA is carried out early in the development cycle, it provides the best opportunity for avoiding impacts and also taking into consideration potential cumulative impacts. It also informs and complements EIA. Plans and programmes are also subject to an appropriate assessment if they have possible impacts on the Natura 2000 network, in which case there must also be a SEA[36].

Table 3-2: Comparison of main legal and procedural differences between SEA, EIA and appropriate assessment

SEA	EIA	AA
Assessment of potential impacts of certain plans and programmes on the environment	Assessment of potential impacts of certain projects on the environment and on biodiversity	Assessment of potential impacts of plans and projects on Natura 2000 sites
Some mandatory, some via screening, some exempt	Some mandatory, some only above threshold, others via screening	All plans/projects with potentially significant impacts
Informs decision-making on planning ('take into account')	Informs decision-making on permitting/licensing ('take into consideration')	**Legally binding** decision based on the precautionary principle
Potential short/long-term, direct/indirect, synergistic and cumulative effects on a range of environmental factors, including flora, fauna and biodiversity and their interrelationship	Potential short/long-term, direct/indirect effects on a range of environmental receptors and on biodiversity (including flora and fauna)	Potential short/long-term, direct/indirect and in-combination effects on conservation interests, conservation objectives and site integrity of Natura 2000 sites only
Compulsory consultation of authorities and public likely to be concerned	Compulsory consultation of authorities and public likely to be concerned	Not obligatory, but encouraged 'if appropriate'

Source: Compilation based on Gonzalez *et al.* (2012); McCracken (2010); Royal HaskoningDHV (2012).

The SEA process involves a number of steps: the most relevant ones for the inclusion of biodiversity are screening, scoping (including the development of the Environmental Report), consultation and monitoring. The SEA Directive (like EIA) does not intrinsically require the avoidance or reduction of impacts that are identified in the process, but if correctly applied, SEA should help to:

- build biodiversity objectives into land-use, urban or sectoral policies, plans and programmes, at different levels (international to local);
- identify and manage apparently minor impacts, which when accumulated may pose severe threats to biodiversity;
- identify biodiversity-friendly alternatives and mitigation strategies that would be compatible with sustained delivery of ecosystem services;

[36] Article 3(2) (b) of the SEA Directive states that 'plans and programmes which, in view of the likely effect on sites, have been determined to require an assessment pursuant to Article 6 or 7 of [the Habitats Directive]' are subject to compulsory SEA.

- ensure that effective monitoring programmes are in place to provide information about biodiversity;
- allow biodiversity specialists and decision-makers and/or planners to engage; and
- integrate biodiversity into a range of activities affecting the way environmental resources are dealt with, such as agriculture, minerals and forestry, from the level of central government downwards.

The European Commission has developed or provided a range of guidance documents on integrating biodiversity considerations into SEA (**Box 3-3:**). Many of the general principles and recommendations are also relevant to the integration of ecosystem service considerations into systems of spatial planning across the EU. According to the European Commission (McGuinn *et al.*, 2013), those undertaking a SEA are advised to consider:

- How will the plan or programme influence biodiversity, and how it will be influenced by biodiversity issues, actions and opportunities?
- How could biodiversity considerations pose a challenge to the assessment process?
- How will this affect information needs — what type of information, what sources and what stakeholders will hold information and specific knowledge in these areas?
- What are the key aspects to cover in the detailed assessment and how important will those issues be in decision-making?

In order to address biodiversity issues effectively, the guidance states that SEAs should:

- consider potential biodiversity impacts of plans and programmes throughout their development, starting from the earliest stage. Biodiversity needs to be considered at the screening and scoping stages and built into the mind-set of all the key parties, including competent authorities and policymakers, planners, SEA practitioners and other stakeholders. The SEA can be used as a creative process to support learning amongst all these parties;
- use ecosystem services to provide a framework for assessing biodiversity impacts and opportunities, as well as interactions with other environmental issues;
- look for opportunities for enhancement where available;
- tailor consideration of biodiversity to the specific context of the plan or programme, rather than using a standardised 'checklist of issues';
- ensure coherence with existing biodiversity objectives and targets, and consider which of these need to be integrated into the plan or programme;
- identify and bring together all the stakeholders and environmental authorities to help to identify and address the key biodiversity issues;

- employ a practical, common-sense approach, which is flexible to the needs and interests of stakeholders and gives sufficient time to properly assess complex information;
- consider the biodiversity context and relevant issues at all levels – local, regional, national and where relevant European and global;
- assess alternatives that make a difference in terms of their effects on BES, and seek to foresee and avoid adverse impacts at the options appraisal stage (e.g. impacts on Natura 2000 sites) to avoid problems at the EIA/ project level; and
- first seek to avoid biodiversity effects and then mitigate, seeking to achieve 'no-net-loss' of biodiversity.

Critical challenges and considerations for addressing biodiversity in SEA are to:

- Consider long-term trends in biodiversity with and without the proposed plan or programme, in order to assess the plan or policy against the future baseline.
- Consider what existing biodiversity objectives and targets need to be integrated into the plan or programme.
- Consider the long-term and cumulative effects on biodiversity, having regard to thresholds and limits, areas that may be particularly adversely affected and the key distributional effects. Use vulnerability assessments to help assess changes to the baseline environment and identify the most resilient alternative(s).
- Address uncertainty, using tools such as scenarios where systems are complex and data imperfect, and including appropriate management and monitoring of risks.
- Develop more resilient alternatives and solutions based on 'win-win' or 'no regret'/'low regret' approaches to plan and programme development.
- Base recommendations on the precautionary principle and acknowledge assumptions and limitations of current knowledge.

SEA will normally be guided by spatial plans at the regional and local level, which as described above can have an important role to play in conserving BES. However, many Member States have not developed, or have scrapped large-scale spatial plans, and therefore consideration of the location of developments and their potential impacts is often carried out in the absence of high-level spatial policy and related guidance. This makes it difficult to strategically address some of the core concerns regarding the appropriate scale and location of developments, and their impacts on BES.

The European Commission carried out a REFIT evaluation of the SEA Directive[37] over 2017–2019, and recently published its findings (European Commission, 2019c) and the supporting study report (Milieu and Collingwood Environmental Planning, 2019). Overall, the Directive

[37] https://ec.europa.eu/environment/eia/sea-refit.htm

was found to be fit for purpose. Other conclusions of particular relevance to this guidance were that SEA appears to be particularly effective with respect to the conservation of biodiversity, but is less so regarding ecosystem services and natural capital. Although the Directive's framework provides sufficient flexibility to accommodate ecosystem service concepts (as objectives and tools) these have not been sufficiently addressed, in part due to limited methods, tools, and data; as well as the lack of a clear legal requirement. There is, therefore, scope for further and improved practical use of SEA to contribute to NNL of ecosystem services.

Box 3-3: Sources of further guidance and information on the treatment of biodiversity and ecosystem services in SEA

- *Commission's Guidance on Implementation of Directive 2001/42 on the Assessment of the Effects of Certain Plans and Programmes on the Environment*. https://ec.europa.eu/environment/archives/eia/pdf/030923_sea_guidance.pdf
- European Commission (2005) *The SEA Manual - A Sourcebook on Strategic Environmental Assessment of Transport Infrastructure Plans and Programmes*. https://ec.europa.eu/environment/archives/eia/sea-studies-and-reports/pdf/beacon_manuel_en.pdf
- Scottish Executive, Welsh Assembly Government, Department of the Environment, Northern Ireland (2005) *A Practical Guide to the Strategic Environmental Assessment Directive - Planning, Building and the Environment*. Department for Communities and Local Government, Office of the Deputy Prime Minister.
- Greening Regional Development Programmes Network (2006) *Handbook on SEA for Cohesion Policy 2007-2013.*
- OECD (2010) *Strategic Environmental Assessment and Ecosystem Services*
- Sadler, B., Dusik, J., Fischer, T., Partidario, M., Verheem, R., and Aschemann, R. (eds) (2010) *Handbook of Strategic Environmental Assessment*. Routledge.
- European Commission (2013) *Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment*. https://ec.europa.eu/environment/eia/pdf/SEA%20Guidance.pdf
- Conference material: International experience and perspectives in SEA, 26-30 September 2005, Prague, Czech Republic. A special thematic meeting of the International Association for Impact Assessment.

3.3 Environmental Impact Assessment

3.3.1 The EIA process

EIA is a process designed to ensure that projects likely to have significant effects on the environment because of their nature, size or location are subject to an assessment of these effects before development consent is given (see **Box 3-4** for the steps in the process). EIAs are mandatory for certain types of large infrastructure or development[38], and screening

[38] Including large power stations, refineries, oil/gas and groundwater extraction, metal, chemical and pulp/paper factories, waste disposal and wastewater treatment plants, quarries and mines, long distance transport infrastructures, pipelines and dams, and large animal rearing installations.

procedures should be used to determine whether EIAs are required for other projects that might have significant environmental impacts[39]. EIA legal requirements in the EU are defined by the EIA Directive[40] as amended in 2014[41]. The revised Directive clearly states that measures should be taken to avoid prevent, reduce and if possible offset significant effects on biodiversity (with particular attention to the species and habitats protected under the Birds and Habitats Directives)[42]. Measures should contribute to avoiding any deterioration in the quality of the environment and any net loss of biodiversity in accordance with the EU Biodiversity Strategy.

Box 3-4 The principal steps in an Environmental Impact Assessment process

EIA Step	**Tasks**
1: Project screening	Determine whether significant impacts are likely and whether these merit formal impact assessment.
2: Scoping	Set terms of reference for the assessment. Review proposed project activities and likely implications in order to design an impact assessment which captures the main issues. Confirm consultation requirements.
3: Consideration of alternatives	Consider alternative locations, designs, methods, timeframes to avoid or minimise adverse effects.
4: Baseline review and population assessments	Define biodiversity distributions (temporal and spatial) and baseline conditions. Baseline = state and condition of biodiversity in the absence of the proposed project and accommodates trends, i.e. not just a static 'snapshot'.
5: Identification and prediction of main impacts	Identify ways in which the proposed project activities will drive changes in baseline conditions. Focus on key issues and provide evidence if possible.
6: Evaluation and assessment of impact significance	Apply the precautionary principle and consider criteria/set thresholds (adopted from existing legislation and policy where possible and appropriate) for determining significance.
7: Recommendations for mitigation and offsetting/compensation	Make suggestions in order to achieve 'no-net-loss' of biodiversity. Seek avoidance ahead of damage limitation or offsetting/compensation.
8: Production and review of Environmental Impact Statements	Produce a report documenting the results of the assessment. Ensure the EIA framework allows for consultation on the draft/peer review.
9: Decision-making	Use the results of the EIA to support decision-making.
10: Post-decision monitoring, auditing and follow-up	Ensure that the results of the EIA are built into environmental management systems for project implementation and operation. Review performance against any objectives and ensure mitigation as well as compensation measures have been implemented as proposed and achieve their intended ecological functions. Ensure there is a mechanism for remedial action if necessary.

Source: EFTEC and IEEP *et al.* (2010), adapted.

[39] In agriculture, silviculture, aquaculture, industry (metals, minerals, energy, chemicals, food, textiles and biomass, etc.), infrastructure, and certain other industrial, urban and rural developments.
[40] Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.
[41] Member States had to amend their national and regional legislation in order to comply with the new rules by 16 May 2017 at the latest, hence also needed to update their EIA Regulations and guidance. .
[42] Article 3.1(b) in Directive 2014/52/EU.

The EIA process provides an opportunity to identify suitable measures that may avoid or reduce potential detrimental impacts and, if necessary, offset residual impacts, in accordance with the mitigation hierarchy. EIAs may help avoid and reduce impacts by considering alternatives to the proposed development (now mandatory under the revised EIA) and mitigation measures, such as changes in the project design. If these measures are not sufficient to reduce residual impacts to acceptable levels the EIA may result in the rejection by competent authorities of the proposed projects. However, it is import to note that, as with SEA, the Directive is a procedural instrument, and does not *per se* result in an obligation for a competent authority to reject a project, even if it is likely to lead to significant environmental damage, or to achieve NNL. Nevertheless, if correctly applied, it should at least contribute to these goals.

EIAs can interact with other EU or national legislative instruments and may, for example, trigger or inform an appropriate assessment under the Habitats Directive (

Table **3-2**), that does lead to a mandatory requirement to avoid, reduce or compensate for significant impacts. The 2014 amendments to the EIA Directive include provisions for joint procedures for impact assessments in order to increase their effectiveness and efficiency. Under this, the competent authority is required to coordinate the various individual assessments required under EU legislation (including SEA and appropriate assessments) which may be required by one or more authorities, and to issue one integrated EIA.

Importantly, to be most effective, an EIA should be considered to be an interactive process (rather than just the production of a report) that aims to avoid impacts, then minimise those that cannot be avoided, and finally identify measures that would offset residual impacts. This process can be complex, as biodiversity is complex and the EIA process involves a number of steps, including screening, scoping, assessment, and decision-making, which should be carried out with stakeholder involvement throughout. It is therefore not within the scope of this document to provide detailed guidance on this subject, but a number of information sources are available (see **Box 3-3Box 3-5:**). Also, according to Commission guidance on biodiversity proofing (Medarova-Bergstrom *et al.*, 2014), to be effective, consideration of biodiversity in EIAs should:

- aim to achieve NNL of biodiversity by following the mitigation hierarchy (see Section 2.2). But is very important to ensure that measures are appropriate, such as in terms of their proportionality, reliability and cost-effectiveness, so that the combined measures lead to the best reliable outcome for biodiversity;
- follow the ecosystem approach as set out by the CBD;
- ensure the assessment of impacts and the estimation of the effectiveness of mitigation and compensation measures is in accordance with the precautionary principle, and clearly indicates assumptions, assessment constraints and levels of certainty in impact and mitigation predictions;

- use the best available evidence (taking into account other related assessments, e.g. relevant SEAs) and ensure assessments are fully documented and as transparent as possible;
- be carried out by suitably qualified people, with relevant biodiversity and EIA experience and expertise, and should include consultation with local biodiversity experts, conservation organisations and other stakeholders;
- identify and assess the entire zone of influence of the project over its lifetime and not just its physical footprint, thus, for example, taking into account off-site impacts from pollution and disturbance from noise and light;
- identify habitats and species that occur within the zone of influence (if necessary through adequate field surveys using appropriate methods) that are of particular conversation importance, which should include those that are protected by the Birds and Habitats Directives (the focus of appropriate assessments) and national legislation, but also others that are threatened and/or declining and/or occur in internationally or nationally significant numbers;
- assess impacts on all habitats and species of particular conservation importance throughout the zone of influence of the project, but give particular attention to identifying and assessing impacts on important sites for habitats and species of particular conservation importance, including Natura sites (the focus of appropriate assessments), other protected areas, and other areas that have been identified as being of high biodiversity importance (such as Important Bird Areas[43] and Important Plant Areas[44]) and areas that might be important for ecological connectivity or other ecological functions;
- assess all type of impacts, including loss and degradation of habitats (e.g. from hydrological change, vegetation change, fragmentation and pollution), direct impacts on species (i.e. mortality), and indirect impacts (e.g. from changes in habitat, predators or competitors), as well as secondary impacts (e.g. increased disturbance to areas as a result of new transport links) – see, for example, the overview of potential impacts of a range of development types on biodiversity in Annex 2;
- consider cumulative impacts of other projects and programmes, and aim to avoid and reduce these as a whole;
- identify and describe (e.g. within an accompanying environmental management plan) potential mitigation measures that would reduce unavoidable impacts (see Section 3.3.2);
- Quantify impacts (in terms of their extent, magnitude, duration, timing, frequency, reversibility and certainty), with and without identified mitigation measures, and assess their significance for each habitat and species of particular conservation

[43] https://www.birdlife.org/worldwide/programme-additional-info/important-bird-and-biodiversity-areas-ibas
[44] www.plantlife.org.uk/international/important-plant-areas-international

importance, in relation to baselines that take into account other drivers and pressures on biodiversity;

- identify and describe compensation measures (such as habitat restoration) that would offset residual impacts (i.e. after mitigation) and thereby achieve NNL of biodiversity; quantifying their impacts through appropriate metrics which should take into account the reliability of the offset measures; and
- include adequate monitoring (**mandatory** under the 2014 amendments) and transparent public reporting on biodiversity impacts, and the effectiveness of mitigation measures and compensation measures, and ensure feedback from the results are used to facilitate adaptive management and trigger contingency measures if biodiversity objectives are not achieved (e.g. in terms of achieving no net loss of biodiversity).

Box 3-5: Sources of further guidance information on the treatment of BES in EIA

- CIEEM (2018) *Guidelines for Ecological Impact Assessment in the United Kingdom and Northern Ireland. Third edition.* Chartered Institute of Ecology and Environmental Management, UK.
- CIEEM (2010) *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal.* Chartered Institute of Ecology and Environmental Management, UK.
- CSBI (2015) *A Cross-sector Guide for Implementing the Mitigation Hierarchy*. Prepared by the Biodiversity Consultancy on behalf of IPIECA, ICMM and the Equator Principles Association, Cambridge.
- European Commission (2013) *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*.
- Geneletti, D. (2016) *Handbook on Biodiversity and Ecosystem Services in Impact Assessment*. Edward Elgar Publishing.
- Hardner, J.J., Gullison, T., Anstee, S., and Meyer, M. (2015) *Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning*. Multilateral Financial Institutions Working Group on Environmental and Social Standards.
- International Association on Impact Assessment (IAIA) wiki page, http://www.iaia.org/iaiawiki/biodiv.ashx
- International Association on Impact Assessment (2005) *Biodiversity in Impact Assessment*.
- Ministère de l'écologie (2013) *Lignes directrices nationales sur la séquence éviter, réduire et compenser les impacts sur les milieux naturels*. Ministère en charge de l'écologie, Paris.
- Slootweg, R., Kolhoff, A., Verheem, R., and Höft, R. (2006) *Biodiversity in EIA and SEA*. Commission for Environmental Assessment, The Netherlands.
- Treweek, J.R. (1999) *Ecological Impact Assessment*. Blackwell, Oxford.

3.3.2 Mitigation measures to avoid and minimise impacts

A wide variety of mitigation measures can often be identified (such as in SEA and EIA processes) and carried out to avoid, or at least minimise, impacts on BES from developments. These include:

- Cancelling the project after re-assessing its justification on the basis of its social, economic and environmental impacts and benefits.
- Spatial mitigation measures, such as locating the development in an area that ideally avoids significant impacts or at least reduces them (which often depends on the degree to which alternative development options are considered in the impact assessment process) or measures that reduce the footprint of the development.
- Temporal mitigation measures, such as carrying out activities at times that avoid or minimise impacts (e.g. in the construction of a development, or ongoing activities involved with the development).
- Technical mitigation measures, for example, those that may reduce pollution from the development, noise or other forms of disturbance, or sources of mortality (e.g. badly designed electricity power lines that may electrocute birds).
- Management mitigation measures, for example, activities that prevent animals accessing food at waste sites, thereby avoiding an increase in predator populations.

All relevant and feasible mitigation measures should be identified and incorporated into the proposed plans for any development that may have significant detrimental impacts; and then considered and described in the environmental statements produced as a result of SEAs (primarily regarding spatial avoidance measures) and EIAs.

There are too many potential mitigation measures to provide advice on these within the scope of this guidance. However,

Box 3-6 provides sources of information on mitigation measures relating to some of the sectors that can have high biodiversity impacts, but also the potential to mitigate them. Although some of these documents relate to Natura 2000 and/or species and habitats protected under the Birds and Habitats Directives, many of the mitigation measures are of wider relevance, and may also help reduce impacts on ecosystem services.

The proposed mitigation measures should then be taken into account in the planning processes and incorporated into development permits (e.g. as a Compensation, Mitigation and Monitoring Agreement). However, there is widespread evidence that agreed mitigation measures are often not implemented, because they are not legal requirements, or are for other reasons to some extent ineffective. Therefore, to help ensure measures avoid or minimise impacts, mitigation measures should:

- have a sound legal basis such that they are mandatory and implemented if the development goes ahead, and remain as long as the impacts they address also remain;
- be clearly defined with SMART biodiversity and ecosystem service objectives (e.g. limiting pollution levels, or maintaining species numbers or ecosystem service indicators within the impact zone within measurable limits) that meet legal obligations and are agreed by relevant stakeholders;
- be realistic and based on sound scientific principles and evidence-based best practice;
- take into account uncertainty, by incorporating additional contingency measures, with contingency plans and systems for long-term adaptive management;
- have strict timetables so that they address significant detrimental impacts before they occur;
- have clearly defined roles and responsibilities for their successful implementation and independent monitoring;
- have sufficient long-term arrangements (e.g. finance) to provide the necessary ongoing mitigation; and
- are adequately monitored and publicly reported on in relation to their stated objectives.

If, as a result of monitoring, mitigation is found to be ineffective, and therefore residual impacts are higher than expected, the planned mitigation measures should either be rectified (e.g. through adaptive management actions) or further/alternative feasible mitigation measures carried out, and their impacts monitored. If at the end of this process significant residual impacts remain, then offsetting should be carried out to achieve NNL or NG (which may mean creating new offsetting plans or adding to those that were envisaged).

Box 3-6: Selected key sources of guidance on mitigation measures for BES impacts

- European Commission. Guidance on the Management of Natura 2000 sites. https://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm
- ICMM (2006) *Good Practice Guidance for Mining and Biodiversity*. International Council on Mining and Metals.
- Iuell *et al.* (2003) *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions*.
- Conservation Evidence – online evidence of the impacts of individual conservation interventions, www.conservationevidence.com
- Van Der Ree, R., Smith D.J. and Grilo C. (2015) *Handbook of Road Ecology*. John Wiley and Sons, Chichester.

3.4 Ecosystem services and SEA/EIA

Impact evaluation with respect to ecosystem services is not included in either the SEA or the EIA Directive. This appears misaligned with the NNL ambitions included in the European Biodiversity Strategy, which include evaluation and mitigation for both biodiversity and ecosystem services for projects, plan and programmes financed by the EU. However, the revision of the EIA Directive[45] has not resulted in ecosystem service impact evaluation being included in the process, possibly, as the MAES has yet to be concluded. Progress has been made, including several Member States exploring whether the inclusion of ecosystem services in impact evaluations has benefits. For example, in France, the 2016 law on biodiversity mentions ecosystem services. Although it doesn't explicitly require that ecosystem services be considered in mitigating and offsetting development impacts on biodiversity, such concerns are increasingly being included in the scope of SEAs and EIAs. The 2014 Report by the World Resources Institute (Landsberg *et al.*, 2014) provides both an explanation on how to include ecosystem services in the impact assessment process, as well as on how to prioritise among ecosystem services, and such approaches are increasingly used outside Europe for projects seeking international financing. Recent academic studies have also explored this topic in relation to SEA (e.g. Geneletti, 2012; Partidario & Gomez, 2013), EIA and offsetting (Baker *et al.* 2013; Jacob *et al.* 2016; Sonter *et al.* 2019) and a proposed integrated framework for mitigating impacts on biodiversity and ecosystem services (Tallis *et al.*, 2015).

A recent Flanders evaluation[46] concluded that identification and quantification of ecosystem services results in a higher quality of SEAs and planning processes. There are several reasons for this. One important reason is the increased engagement of stakeholders. As the importance of ecosystem service benefits is largely defined by the affected stakeholder groups, it is highly recommended that these stakeholders are allowed to express their opinions on which ecosystem services they consider important at an early stage in the process. An ecosystem service-integrated EIA process leads to more consensus at a local level and increased acceptance and ownership of the final decisions. In particular, for controversial plans and projects with severe risk of delays and opposition, an ecosystem-based approach including ecosystem service assessment results in a more inclusive and participatory process. Reducing delays caused by opposition will result in a shorter overall timeline for approving a plan or project.

Therefore, inclusion of ecosystem services in EIA should not be considered as 'gold plating'. It is expected that EIAs that have integrated ecosystem services will be more effective in terms of EIA costs (and when compared to total project costs) and in terms of results. Moreover, an ecosystem service-integrated approach increases the insight among stakeholder groups that well-functioning ecosystems provide many societal benefits. As a result, people become aware that ecosystems should be used in a sustainable way, instead

[45] https://ec.europa.eu/environment/eia/review.htm

[46] Arcadis for Agency for Nature and Flanders (2017) Scoping Study Evaluating the Added-value of Including Ecosystem Services in Impact Assessment.

of being depleted. Ecosystems change from ‘barriers’ or ‘opponents’ to ‘much appreciated allies’. Preserving or restoring ecosystems will no longer be considered a limiting factor for development, but rather an opportunity for increasing the project’s chances of success. This also results in more resilient and risk-proofed plans and projects.

Finally, valuing ecosystem services gives biodiversity more weight in the decision-making process. By making clear which ecosystem services are generated by biodiversity, biodiversity is viewed through the lens of societal needs. This is also why the concept of ecosystem services is well-suited to ‘storytelling’, for example on the societal benefits of green infrastructure, which is an important element in stakeholder consultations. In some cases, integration of ecosystem service in EIA does not provide added value, such as when there are no affected stakeholders and/or when the scale of the plan or project is too limited to generate substantial changes in ecosystem services benefits.

4 GUIDANCE ON OFFSETTING IMPACTS

4.1 Key principles and essential design considerations

As discussed in Section 2.2, while international evidence shows that well designed and properly implemented offsets can deliver BES NNL, and gains, there are a number of problems that can result in their failure or other undesirable outcomes. In summary, these include:

- practical limitations in accurately and comprehensively measuring BES in a practical and transparent way that can ensure the impacts of developments on BES (i.e. debits) and the BES outcomes from offsets (i.e. credits) are reliably and adequately quantified such that that achievement of NNL can be demonstrated;
- limitations on the ecological feasibility of rehabilitating, restoring or creating ecosystem and their biodiversity and services;
- limitations on the land available for offsetting;
- unavoidable spatial impacts, leading to biodiversity losses and/or difficulties in ensuring equitable outcomes for people;
- lack of implementation of the offset, or non-compliance with design requirements;
- problems with additionality, i.e. ensuring that offsetting leads to impacts that are additional to those that would have occurred anyway;
- leakage of benefits, especially in the case of risk-aversion offsets;
- time lags in the rehabilitation/restoration and offsetting of impacts; and therefore temporary BES losses; and
- lowering of protection levels if the mitigation hierarchy is not appropriately followed, resulting in a so-called ‘licence to trash’.

Such risks should be comprehensively and transparently considered in EIAs and development project permitting procedures, so that the risk that NNL will not be achieved is clear and the potential residual impacts spelled out. A decision should then be made on the project's acceptability, with the possibility of refusing or revising the project being an option. If the expected residual impacts are considered to be acceptable and the project goes ahead then monetary compensation may be made for losses as a very last resort – but it is important to note that this is not offsetting and does not lead to NNL.

However, experience shows that careful design and regulation supported by adequate oversight, monitoring and, where necessary, enforcement of offsets can reduce or eliminate these risks (Wende, Herberg and Herzberg, 2005; Darbi *et al.*, 2009, 2010; McKenney and Kiesecker, 2010; BBOP, 2012a; Gardner and von Hase, 2012; Bull *et al.*, 2013; Conway *et al.*, 2013; Gardner *et al.*, 2013; Tucker *et al.*, 2014; Wende *et al.*, 2018; Ermgassen *et al.*, 2019). This was recognised by the European Parliament, in their Resolution on 20 April 2012 which 'Urges the Commission to develop an effective regulatory framework based on the "No Net Loss" Initiative, taking into account the past experience of the Member States while also **utilising the standards applied by the Business and Biodiversity Offsets Programme** [emphasis added].'

The BBOP Principles are presented in Box 4-1**:**. These and the accompanying Standard on Biodiversity Offsets (BBOP 2012d), which is intended to help determine whether an offset has been designed and subsequently implemented in accordance with the BBOP Principles, are taken into account in the subsequent sections of this guidance. However, it is important to note that these principles need to be interpreted and applied in the EU in the context of its existing policy and legal framework, and environmental characteristics and pressures.

Box 4-1: The BBOP Principles on Biodiversity Offsets

These principles establish a framework for designing and implementing biodiversity offsets and verifying their success. Biodiversity offsets should be designed to comply with all relevant national and international law, and planned and implemented in accordance with the CBD and its ecosystem approach, as articulated in National Biodiversity Strategies and Action Plans.

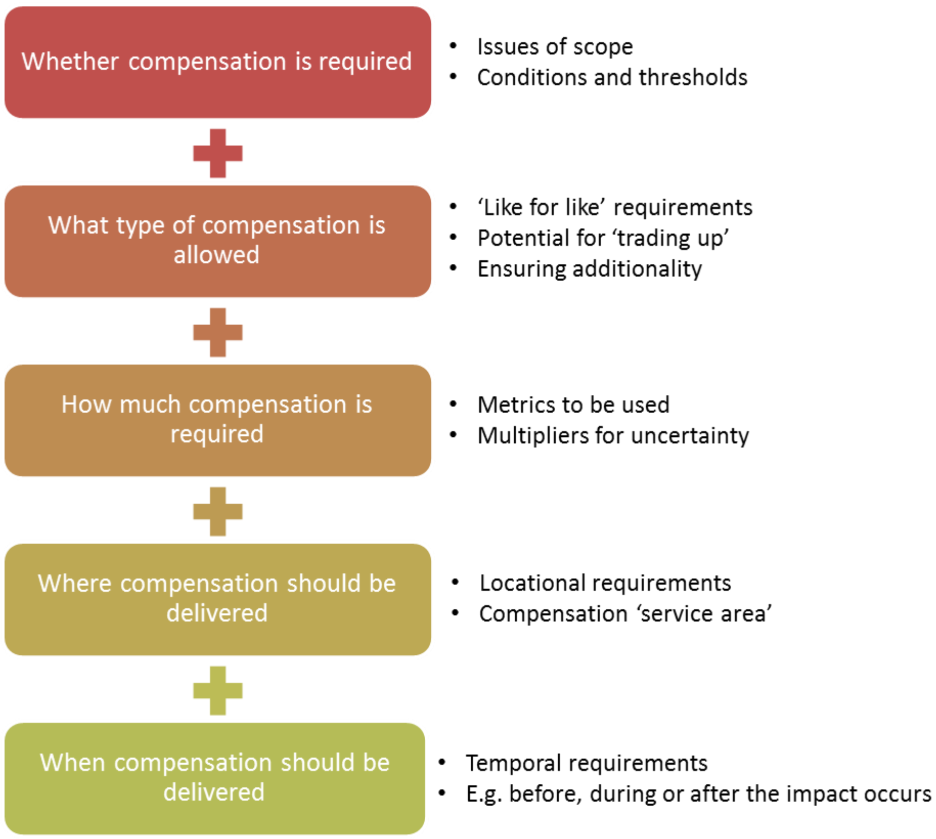
1. **No net loss:** A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.
2. **Additional conservation outcomes:** A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations.
3. **Adherence to the mitigation hierarchy:** A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimisation and on-site rehabilitation measures have been taken according to the mitigation hierarchy.

4. **Limits to what can be offset:** There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.
5. **Landscape context:** A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes, taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.
6. **Stakeholder participation:** In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring.
7. **Equity:** A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special consideration should be given to respecting both internationally and nationally recognised rights of indigenous peoples and local communities.
8. **Long-term outcomes:** The design and implementation of a biodiversity offset should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in perpetuity.
9. **Transparency:** The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.
10. **Science and traditional knowledge:** The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge.

Note: While biodiversity offsets are defined here in terms of specific development projects (such as a road or a mine), they could also be used to compensate for the broader effects of programmes and plans.

To be able to achieve NNL in accordance with these principles, biodiversity offsets need to be carefully designed and fully implemented, with key considerations as set out **Figure 4-1** taken into account. These are further described below, drawing on the BBOP standard (BBOP, 2012d), related design handbook and resource papers (BBOP, 2012a, 2012c, 2014), and previous EU relevant studies (EFTEC and IEEP, 2010; Conway et al., 2013; Rayment et al., 2014; Tucker et al., 2014). Although these studies are primarily focused on biodiversity their key principles are largely applicable to offsetting ecosystem services.

Figure 4-1: Key design elements for biodiversity and ecosystem offsetting



Source: Adapted from Tucker *et al.* (2014).

4.2 Deciding on whether compensation is required

4.2.1 The scope of the NNL or net gain objectives

A key question to consider when establishing an offsetting scheme, or aiming to achieve NNL in relation to particular impacts (e.g. at a sector, region or project level) is whether it should only cover habitats and/or species, or if it will extend to wider ecosystem service benefits. In order to meet the EU's headline target of halting the loss of BES, it is necessary for all habitats, species and ecosystem services to be potentially within the scope of the NNL objective. However, it is clearly not feasible to address impacts on everything, and therefore to make NNL policy measures proportionate, practical and efficient it is recommended that **offsetting should seek to achieve NNL of habitats and species that are threatened, scarce or declining species, or ecosystem services that are in short supply** (to be identified through public participation involvement, such as stakeholder consultation). It is a legally mandatory requirement for offsetting to be carried out for detrimental impacts on EU protected species and habitats species within Natura 2000 under Article 6.4 of the Habitats Directive. However, as Commission guidance exists on these measures (

Box **1-3:**), these current guidelines focus on other scarce and declining habitats and species, as well as ecosystem services.

It is not within the scope of these guidelines to indicate precisely which habitats and species should be considered to be sufficiently scarce and/or declining to be the subject of NNL objectives, but it is suggested the following should be included as a minimum:

- EU protected species and habitats where they occur outside Natura 2000 sites (i.e. migratory birds and other bird taxa listed in Annex I of the Birds Directive, and habitats and species listed in Annexes I and II of the Habitats Directive, respectively) – therefore complementing legal requirements under Article 6.4 of the Habitats Directive;
- habitats and species that are considered to be globally or regionally threatened according to International Union for Conservation of Nature (IUCN) criteria; and
- habitats and species that are nationally or regionally scarce and/or declining and listed in national or regional biodiversity strategies/action plans or similar recognised documents.

Focusing on these habitats and species may, however, still lead to significant biodiversity losses of more common and widespread species, especially in areas with few rare species and/or countries and regions that narrowly define threatened biodiversity. It is therefore also recommended that offsetting objectives should be to more broadly achieve NNL of species communities or the habitat in general, for example by complementing scarce or declining target species with additional multiple umbrella species as targets that will better capture the full suite of impacted biodiversity and ecological processes. Consideration should also be given to habitats and species that underpin important ecosystem services (further discussed below), for example, including common species that are also considered to be of cultural importance (e.g. Pellegrin *et al.*, 2018).

Although a wide range of different types of offsets are now carried out around the world, for a variety of regulatory to voluntary reasons (Darbi, 2020), most focus on biodiversity considerations, leaving residual impacts on ecosystem services largely or completely uncompensated (Jacob *et al.*, 2016; Sonter *et al.*, 2018, 2019). In Europe, offsetting examples being carried out at scale include Austria (Artmann, 2018), the Netherlands (van Teeffelen, 2018), Germany (Wende *et al.*, 2018) and France (Vaissière *et al.*, 2018). The current system in Germany ensures that losses to both biodiversity and some wider ecosystem services are covered (**Box 4-2:**), whereas in France the focus is largely on compensating for impacts on species and wetlands. However, in order to achieve the EU's objective of NNL of ecosystem services, as well as biodiversity, it will be necessary to expand offsetting to ecosystem services where this is feasible. As there is little experience of carrying this out (except in Germany, where they are treated in a relatively simple manner – see discussion on metrics in Section 4.4.1) it is not possible here to provide guidance on best practices. The guidance provided below therefore primarily relates to experiences from biodiversity offsetting, but in many cases the practices that are put forward will also be applicable or adaptable to some extent to ecosystem services. It also takes into account proposals for incorporating ecosystem services into offsetting made by Tallis *et al.* (2015), Jacob *et al.* (2016) and Sonter *et al.* (2019); but readers are referred to the original paper for their details.

Box 4-2: The legislation requiring offsetting in Germany and its scope

Germany's Impact Mitigation Regulations (IMR) provide a good example of a relatively strict and mandatory policy implementation for restoring ecosystems, their services and also for biodiversity offsetting (Albrecht *et al.*, 2014). These Regulations were adopted in 1976 as part of the Federal Nature Conservation Act. They address the mitigation, compensation and offset of impacts from developments and projects. Precautionary in nature, they are not only related to biodiversity but also constitute an instrument of landscape conservation. The IMR have to be applied at the level of individual projects, such as the development of new residential areas or the construction of roads.

The main objectives of the IMR are to avoid significant negative effects and to ensure compensation for impacts on natural assets such as habitats, soil, water, climate and air quality, as well as the aesthetic quality of the landscape. At a minimum, the existing ecological situation is to be preserved (the 'no net loss' principle).

As part of the proposed integrated framework for biodiversity and ecosystem service mitigation, Tallis *et al.* (2015) discuss the importance of identifying 'target ecosystem services'. They highlight that this is challenging because there are many potential ecosystem services that are unique, non-interchangeable and determined by related but often quite different environmental factors. Furthermore, data and resource limitations restrict the number of ecosystem services that can be considered in impact assessments and offsetting schemes. Therefore, in practice, some form combination of closely related services and prioritisation is required. Thus, services could be targeted if they are expected to suffer the greatest losses from the proposed development, and/or are of highest social or commercial value for their continued delivery (Luck *et al.*, 2012). The identification of such services may draw on stakeholder engagement approaches (Rosenthal, 2015). Expected marginal changes (i.e. losses and gains) in the target ecosystem services from the residual impacts of the proposed development should then be assessed, and those that are considered to be unacceptable should then be subject to avoidance, first, and offsetting if necessary (as further described in Section 4.3.2).

4.2.2 Conditions and thresholds

A further key consideration when deciding on the scope of offsetting are the circumstances in which offsetting measures should be taken to achieve NNL, that is, What are the impact thresholds at which BES losses are considered to be sufficiently unacceptable to require offsetting? For example, offsets could be required for all development activity, or only for projects that have impacts above a certain level. However, this may result in disproportionate impact assessment and measurement burdens for small developments or activities that have limited environmental effects. Thus, it may also be appropriate to limit offsetting requirements to certain types of development and/or or large-scale developments that are most likely to have substantial impacts, in which case reference may be made to the developments that require EIA and SEA (as indicated in the SEA and EIA Directives' annexes). Offsetting might also be limited to protected habitats and species (i.e. beyond those covered by requirements under the Birds and Habitats Directives) or those listed as requiring conservation in National Biodiversity Strategies and Action Plans. Appropriate thresholds for offsetting ecosystem services, will be context specific, and will therefore need to be agreed through impact assessment procedures and decision-making processes (e.g. see European Commission, 2019a).

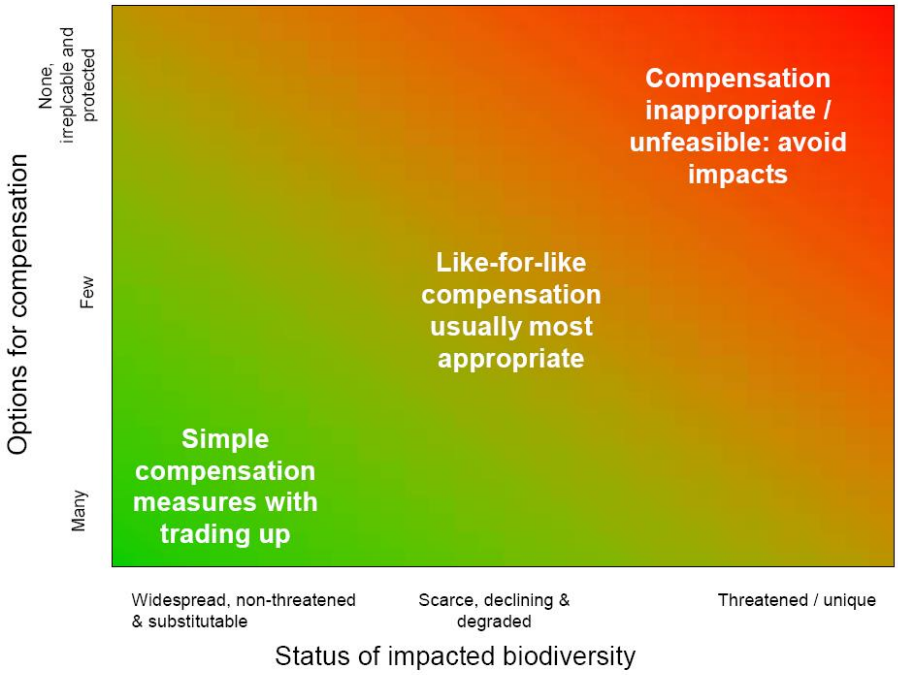
4.3 Deciding on what type of compensation is allowable

4.3.1 Exchange rules

To avoid BES losses it is necessary to adopt exchange rules that normally require like-for-like (in-kind) offsetting. For biodiversity this means compensating for losses through offsets that provide gains in the same habitat types and species, and in some cases the same sub-species/populations or local genetic stock. To enable this for ecosystem services a clear and fine-grained typology is required for defining an ecosystem service that is meaningful and agreeable to the impacted 'ecosystem service beneficiaries' (as identified through consultations).

However, 'out-of-kind' biodiversity offsetting can be appropriate in some circumstances, particularly where the biodiversity affected is not especially vulnerable or irreplaceable, in which case it may be beneficial to allow the flexibility to 'trade up' to preserve the biodiversity of a higher conservation value than that affected. The more vulnerable and irreplaceable the affected biodiversity, the tighter the 'like-for-like' requirement should become (see **Figure 4-2**).

Figure 4-2: Appropriateness of compensation in relation to the importance of impacted biodiversity and availability of reliable compensation options



Source: Adapted from BBOP (2009).

Threatened habitats such as those listed in Annex I of the Habitats Directive should be subject to strict like-for-like compensation, as clearly indicated in Commission guidance (European Commission, 2007). Offsets for such habitats should therefore match those specifically defined in the Directive, and not broader types of habitat (e.g. deciduous forest). For habitats of moderate potential ecological value (and outside Natura 2000 and other protected areas), it is appropriate to define habitats, and therefore offset requirements, more broadly. Where habitats of low ecological value are impacted then it would often be appropriate to trade-up.

Importantly, it is generally considered to be inappropriate for offset habitats to be of lower potential ecological value than the impacted habitat, because this risks the loss of biodiversity attributes that are not fully captured in metrics.

Ensuring like-for-like offsetting of ecosystem services is extremely difficult because multiple services are likely to be affected by most developments and their values will vary significantly from one site to another, and will be context specific. Complex trade-offs are therefore often necessary as enhancing one service usually results in depletion of another. Solving such problems normally requires close consultation and negotiation with affected stakeholders (see Section 4.2.1), informed by the use of robust ecosystem service specific metrics (e.g. those described in European Commission, 2019a). However, the application of ecosystem service indicators and metrics to offsetting is in its infancy.

4.3.2 Mechanisms for offsetting losses and ensuring additionality

Offsets are normally carried out by increasing the BES value of an area, usually by restoring or recreating degraded or destroyed ecosystems, or in some cases creating new habitats or enhancing existing habitats (e.g. woodland management measures to increase regeneration and species and structural diversity). A key advantage of this type of offset is that it is relatively straightforward to measure the BES values before and after the offset has taken place.

However, in some situations there may be few suitable opportunities to increase the value of ecosystems, such as in the marine environment. Also it is very difficult to restore or recreate some habitats, and impossible to restore some within reasonable timescales, such as ancient natural forest or peatbogs (Morris *et al.,* 2006; BBOP, 2012b). Therefore, in some circumstances, it may seem more appropriate to carry out offsetting by reducing ongoing or expected detrimental impacts on an ecosystem (such as from pollution), species (e.g. from hunting) or service (e.g. carbon losses from eroding soils); thereby providing a gain (credit) in biodiversity or ecosystem service value compared to the counterfactual situation (i.e. what would have happened if the offset hadn't taken place). However, as noted by Hansjügens *et al.* (2011) and Maron *et al.* (2018), these **averted risk offsets** can only deliver gains where there are significant areas of remaining ecosystems that are:

- worth maintaining;
- unprotected and likely to remain so in the future (to ensure additionality); and
- subject to significant and predictable levels of loss or degradation.

Therefore, there is a particularly high risk of under-delivery of expected credits / gains from averted risk offsets in the EU because:

- the potential for averted risk offsets offsets to provide reliable long-term additional benefits is likely to be somewhat limited given that a large proportion of European habitats that are threatened with degradation are already protected to some degree;
- the likely gains from averted risk offsets offsets are highly uncertain as they depend on future rates of habitat-specific loss and degradation, which are extremely difficult to predict reliably and will vary greatly from place to place; and
- there is a considerable risk that the benefits of the protection of the offset area from a threat (e.g. mineral extraction) will merely result in the displacement of the threat to another area (i.e. offset leakage).

For such reasons averted risk offsets are not allowed in many countries, such as in Germany, rarely accepted in France, and only allowed in exceptional circumstances in the USA under the Mitigation Banking Regulation (Morandeau and Vilaysack, 2012). There is a growing awareness that averted loss offsets can only deliver a 'managed net loss' from development, rather than NNL (Simmonds *et al.*, 2019).

Given these risks, **averted risk offsets are not recommended where other offsets can be used more reliably**. Where averted risk offsets are the only option for achieving NNL they should be subject to stringent safeguards and monitoring to ensure they result in long-term additional benefits, including obligatory contingency measures (e.g. increasing the area of offsetting).

According to Jacob *et al.* (2016), unacceptable residual impacts on ecosystem services can be offset through the following three types of complementary approaches:

1. **Nature-based complementary measures,** which compensate with natural capital. These are measures based on ecological restoration or other actions that restore nature, such as biodiversity offsets (e.g. creation of community woodlands to compensate for restricted access of local communities to forests due to the project).
2. **Human-based complementary measures**, which substitute natural capital with human-made capital (e.g. waste-water treatment facility to substitute for water quality services that would be lost from a wetland).
3. **Financial complementary measures**¸ which compensate populations that have lost ecosystem services (e.g. reductions in incomes from fish catches).

Under this framework, project proponents negotiate with stakeholders that are affected by unacceptable losses of ecosystem services, to agree a mix of complimentary offsets that meet their requirements. It should therefore be noted that this may not result in NNL of the ecosystem services or their benefits, and may result in declines in natural capital. Jacob *et al.* (2016) note that financial complementary measures have been criticised as being equivalent to 'buying people off'. Furthermore, the more that offsets are based on financial measures, the higher the risk becomes of individual rather than collective offsets. There are also risks that impacted populations may not achieve NNL of ecosystem services as a result of opportunistic developers, a lack of knowledge of their dependence on ecosystem services, or power asymmetries between stakeholders. It is therefore important that such decisions on offsetting are not just based on local community knowledge and views, but informed by evaluations of ecosystem service losses and gains and external scientific information.

Regardless of what type of compensation is being delivered for biodiversity or ecosystem services, a key principle that needs to be applied in every situation is to ensure that the offset results in outcomes that are additional to what would have happened in their absence. Therefore, verification that the offset has the potential to provide additional benefits should be a prerequisite for regulatory approval. Criteria therefore need to be established to assess what is 'additional' and what is not. These may relate to existing obligations, sources of funding that would be allowed, as well as what kind of conservation actions would be permissible.

Clearly there is limited capacity for biodiversity offsets to provide significant and measurable biodiversity benefits within protected areas (including Natura 2000 sites and nationally protected sites). This is because most protected areas do not just aim to maintain the habitats and species within them, but to restore and enhance them when necessary. In theory offsets could provide additional benefits through measures that target biodiversity components or ecosystem services that do not directly, or indirectly, benefit from the protected area and its management (Maron *et al.*, 2016). However, as it is very difficult to reliably assess and monitor the resulting gains, offsets in protected areas have a high risk of under-delivery. According to IUCN (2014), there is some agreement that where governments have limited capacity for funding their protected areas, offset activities could take place in some circumstances in existing protected areas until the time when their capacity is adequate (Hardner *et al.*, 2015). However, this should not apply to countries in the EU (Pilgrim and Bennun 2014). **Therefore taking into account these considerations, biodiversity offsets should NOT normally be carried out within protected areas in the EU.** Offsets that restore or recreate habitats for which there are existing official targets (e.g. in National Biodiversity Strategies and Action Plans) may also provide little additionality, although they may transfer the costs of restoration from the public purse to the private developer, thereby possibly freeing up public funds for other proactive conservation measures (Simmonds *et al.* 2019).

4.4 How much compensation is required?

4.4.1 The use of metrics to calculate losses and potential gains

A fundamental element of ensuring NNL is the quantification of residual impacts (debits) and offset gains (credits) to calculate how much compensation is required. This is a major challenge as biodiversity is complex and multi-dimensional and its value is highly context-specific – thus all measures of it are crude proxies. Furthermore, ecosystem service indicators are still under development, and their application to offsetting is rare and currently simplistic. The situation is made even more complex where out-of-kind offsetting is considered and trading occurs with habitat banks (see Section 4.5.3). Offsetting **metrics** are therefore required that use common units of biodiversity to measure changes on the impacted site and the offset site, so that losses and gains can be calculated, which enables equivalency and NNL to be assessed and thereby allows trading (Quétier and Lavorel, 2011).

A European Commission study (Rayment *et al.*, 2014) identified good practices with respect to the use of offsetting metrics, and recommended that when calculating losses and gains, these should be defined as follows:

- **Loss** = predicted situation for an affected area's biodiversity with no project impact minus the predicted situation for the affected area after avoidance, minimisation of impact and restoration.
- **Gain** = predicted situation for an offset area's biodiversity after the offset's conservation activities (e.g. restoration and/or management activities), adjusted for

risk factors associated with these predictions, minus the predicted situation for the offset area with no offset intervention.

The loss and gain calculations also need to take into account:

- areas that are directly affected by the activity of concern, and areas that may not be completely converted by the activity, but may be affected indirectly, resulting in a decline in biodiversity or ecosystem service value;
- baselines with respect to the ecosystems, habitats, species and ecosystem services present at the impacted site, and their wider overall local, regional, national and EU status; as such information forms the basis of the assessment of potential habitat values, which are explicitly taken into account in some metrics (see below);
- baselines with respect to expected changes in habitats and species both at the impact site and the potential offset sites; and
- the precautionary principle, as there is normally significant uncertainty in the estimation of baselines and offset impacts.

The varied incorporation and treatment of biodiversity properties and ecosystem services gives rise to a large number of metrics, but according to Rayment *et al.* (2014) the main types of metric can be summarised as follows (although there are many variations and overlaps):

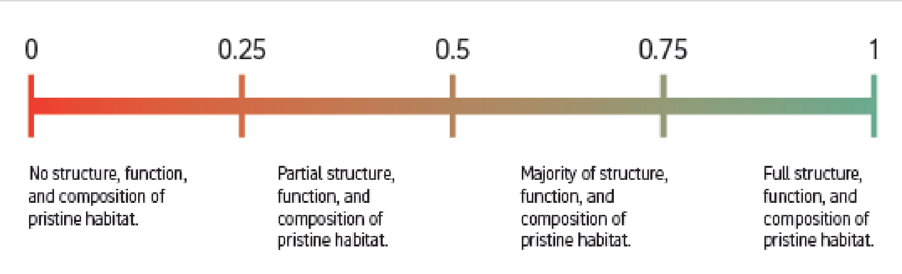
- **Habitat (biotope) area**
  In its most basic form, this metric is simply the area of habitat that is lost and gained. It is extremely simplistic as it assumes that all habitats and hectares within them are of equal value and condition.
- **Habitat (biotope) area x standard value**
  A commonly used form of metric, based on standardised area ratios for individual habitats that reflect their different potential values (e.g. based on their naturalness, species richness and diversity, and rarity).
- **Habitat (biotope) area x site condition**
  A widely used metric based on a multiplication of the area of the impacted habitat by the change in ecological condition (e.g. a change in the percentage of its potential condition; see Box 4-3 for an example of quality scoring) resulting in a currency that is often referred to as 'habitat hectares'.
- **Habitat (biotope) area x standard value x site condition**
  Combines consideration of standardised potential habitat values (expressed as habitat area ratio requirements) with relative site condition assessments to provide an aggregated metric; for example, most offsetting schemes in the USA make use of an area measurement and a value multiplier, and some incorporate an approximate quality assessment based on expert opinion. A variation on this approach developed

in The Netherlands has area x site condition complemented by multiplication with a weighing factor which considers the national rarity and trend (47).

- **Species-focused approaches**
  Assess the expected impacts on defined species' populations, or their habitat; often focusing on one or more threatened species, or umbrella species (i.e. representative of a community of ecosystem).
- **Habitat replacement costs**
  Simply the average cost of replacing the lost habitat multiplied by its area; with the offset requirement being to create an area of habitat of equivalent cost.
- **Ecosystem service-specific metrics**
  Varied ecosystem service indicators.
- **Economic valuation of ecosystem services**
  Various measures of the economic value of ecosystem services.

Box 4-3: Illustration of how to score habitat quality

As an example, habitat quality could be scored from 0 to 1, with pristine habitats receiving a maximal score. The example emphasises the need to consider structure, function and composition as aspects for determining quality.



Source: Derived from Rio Tinto (2012).

Table 4-1 summaries the main advantages and disadvantages of the main types of offset metric.

[47] https://www.sweco.nl/siteassets/pdf/doorontwikkeling-natuurpunten-swnl-0187111.pdf

Table 4-1: Summary of the main advantages and disadvantages of the main types of offset metric

Metric	Advantages	Disadvantages
Habitat (biotope) area	Very simple transparent system with low transaction costs – suitable for impacts on habitats with very low biodiversity values that do not significantly vary in condition.	Does not capture many important values of habitats. Decisions on ratios are largely arbitrary. Particular requirements for species are ignored.
Habitat (biotope) area x standard value	Relatively simple low-cost system that takes into account the average potential ecological values of habitats. In combination with exchange rules allows out-of-kind offsets.	Habitat values can vary greatly according to their condition. Does not take size and spatial issues into account unless by a simple multiplier. Does not enable offsets that enhance habitat condition. Simple habitat metrics are not always good proxies for species requirements (particularly in low-value habitats).
Habitat (biotope) area x site condition	Provides a much more reliable and comprehensive measure of biodiversity value and enables potential habitat condition improvements through restoration/enhancement to be taken into account.	Does not explicitly take into account different habitat values, so can only be used for like-for-like offsets or within bands of type. Condition is difficult to define and measure, complex methods are needed and good-quality data from site surveys, which increase costs and, if poorly planned, could delay projects – so requirements are not considered reasonable for projects that clearly have low-level impacts. Also less transparent and arbitrary weightings are often used for condition attributes. As above for species.
Habitat (biotope) area x standard value x site condition	Considers habitat value as well as condition so allows comparison of different habitat types and therefore unlike-for-like offsets, and offsets that improve condition of existing habitats.	Can be complex and lack transparency. Requires information on habitat values at national and local values, as well as impact and offset site data on condition. Cost likely to be similar to other metrics that assess condition. Simplified systems may not be robust. As above for species.
Species-focused approaches	Often a clear, objective and transparent measure, that may link directly to conservation policies and legislation (e.g. for protected species) and stakeholder concerns (e.g. species of high cultural value).	Cannot capture many important biodiversity values without becoming highly complex – so to achieve NNL it is best used in combination with habitat metrics to identify particular requirements for important species when known to be present. Requires good spatial data and field surveys where these are not already mapped, which increases costs and can delay projects – so requirements are not considered reasonable for projects that clearly have low-level impacts.
Replacement costs	Relatively simple and transparent and can make use of cost information compiled as	Costs of replacing lost habitat can vary considerably, and be difficult to assess

Metric	Advantages	Disadvantages
	part of a Biodiversity Offset Management Plan; particularly suitable for fee-in-lieu systems.	reliably for some habitat types (and some cannot be restored). Simple habitat restoration costs are not likely to be good proxies for some species requirements.
Ecosystem service-specific metrics	The metrics can be chosen to ensure they are appropriate to the service and its context, thus ensuring sensitive and reliable measurements.	Data requirements are likely to be high as several services, which may be location-specific, may need to be assessed each with a different metric, and data needs for each may be significant. The use of a variety of metrics may cause confusion among authorities, developers and stakeholders, hindering learning, communication and interpretation of the results.
Ecosystem service valuation	Valuation (i.e. monetisation of ecosystem service changes) can enable all ecosystem services to be compared, bringing into play tools such as cost-benefit analysis which enable consideration of the 'net' benefit of changes in multiple ecosystem services.	Primary valuation exercises can be financially and labour intensive and are therefore likely to be unfeasible except for the most significant of cases. The existing evidence base for value transfer is limited. Only partial valuation (i.e. of some services) is therefore likely to be possible, and these estimates may not adequately reflect local variations in perceived value.

Source: Rayment *et al.* (2014).

Rayment *et al.* (2014) conclude that the simplest ratio metrics are generally not fit for the purpose of a NNL determination. However, the other metrics all have their strengths and weaknesses and are suitable for use in some situations. There is no single best metric or best-practice approach, and they need to be chosen according to their purpose, according to good practice principles that metrics should endeavour to incorporate (such as ensuring they result in equity in type, space and time of BES). Nevertheless, **metrics incorporating combined assessments of habitat area, standard value and condition are best able to reliably capture key biodiversity values.** Where necessary, species-specific measures should also be used for high-priority species. However, the combination of habitats/species metrics to form combined metrics (e.g. species diversity or more complex indexes) can lead to inappropriate trade-offs and losses of some components (e.g. Maseyk *et al.*, 2016). Therefore, it is best practice to treat each separately unless there is a defendable and transparent rationale for combining them (e.g. an empirically based and tested species index that reflects the key characteristic species of a well-defined community; for further examples see Wende *et al.*, 2018).

The application of metrics to the offsetting of ecosystem services is fraught with difficulties, including the number of different ecosystem services that may need to be addressed and the lack of a standardised typology and definitions, although attempts are being made to address this (e.g. through the MAES process in the EU). Furthermore, **it is normally appropriate to measure and achieve NNL of each ecosystem service separately**, because combined metrics can be difficult to interpret and may mask inappropriate trade-offs (Jacob *et al.* 2016; Sonter *et al.*, 2019). This leads to substantial data requirements as several services, which may be location-specific, may need to be assessed, each with a different metric, and data needs for each may be significant. A further problem is that in practice some features are very difficult to reliably and consistently measure (e.g. landscape aesthetics) and therefore subjective approaches such as verbal argumentation may sometimes be unavoidable. Further challenges occur where economic valuation is desired.

A further complication is that, because ecosystem services are the benefits provided by functioning ecosystems to human well-being, it is important to distinguish and consider the potential services that an ecosystem can supply and the demand (or actual delivery) for them from beneficiaries (Syrbe and Walz 2012). To illustrate this, the ecosystem services protection against flood may have equal potential in a densely built-up versus a remote area, but the ecosystem services demand will be much higher where the population density is high. Moreover, it is also ideally necessary to consider and measure how much the supply of services matters to people, i.e. its value. Hence, it is generally recognised that ecosystem services need to be assessed in terms of their supply, demand (or actual delivery) and values, and that impacts should be estimated in relation to their marginal changes in these parameters (Tallis and Polasky, 2009). However, in practice, data and knowledge gaps often mean that ecosystem service assessments have to be based on biophysical data and functional models.

Offsetting in most countries focuses on biodiversity, and therefore there is very little evidence or experience internationally to draw on in relation to guidance on metrics for offsetting losses of ecosystem services (Sonter *et al.*, 2018). Many ecosystem service indicators are still under development, as there is a lack of knowledge regarding relationships between services and biodiversity and other potential proxy indicators. Consequently, in countries where ecosystem service offsetting is being carried out, the metrics used have often been simplistic and based on judgement. For example, in Baden-Württemberg in Germany, the loss of soil's natural fertility, water cycle regulation, and pollution regulation functions are assessed using a very simple five-level scoring system (**Box 4-3**).

Box 4-3 Assessment of soil related ecosystem services in German offsetting

In Baden-Württemberg, the loss of soil's natural fertility, water cycle regulation, and pollution regulation functions are scored from 1 (minimal loss) to 5 (maximum loss) per hectare of soil lost to sealing (sealed soil is scored at 0). This gives a maximum function loss score of 4 points per ha or a minimum of 1 per ha. After subtraction of any mitigation and restoration measures the remaining score is weighed against the total score of an offset measure or measures, calculated in the same way. The score can also be translated into a monetary value using a standard rule of 1 to 5 euro per m^2, to give a maximum monetary value of €12,500 per ha.

As a result of the problems outlined above, there is no unified framework or methodology for incorporating ecosystem service indicators and metrics into offsetting (Tallis *et al.*, 2015). However, a considerable amount of work is now being carried out on the development of ecosystem service mapping, assessment and valuation methods and tools, many of which may be applicable to development impact assessments and offsetting. Further information on these is provided in a review of valuation methods carried out under the EU FP7 Openness Project (Barton and Harrison, 2017). Mapping and assessment methods, and their related studies, have also been compiled in the ESMERALDA MAES Explorer database and online tool[48], which provides guidance on their use tailored to EU Member States. In addition, the VALUES[49] database provides a global inventory of methods, indicators and tools for integrating ecosystem services into policy, planning and practice, including in relation to calculating environmental damages, losses and compensation requirements. Furthermore, some tools have been developed that attempt to incorporate ecosystem service mapping and assessments into offsetting, with examples provided in Box 4-4.

Box 4-4 Examples of tools that have been developed to support the incorporation of ecosystem services into offsetting

ARIES[50] (Artificial Intelligence for Ecosystem Services) is a networked software technology that redefines ecosystem service assessment and valuation for decision-making. The ARIES approach to mapping natural capital, natural processes, human beneficiaries, and service flows to society is a powerful new way to visualise, value, and manage the ecosystems – and can therefore support offsetting.

ARIES maps the agents of provision of ecosystem services (sources), their beneficiaries (use), and any biophysical features that can deplete service flows (sinks), automatically choosing the best available models and data. Through artificial intelligence and innovative semantic modelling, ARIES assembles spatial data and expert-contributed model components – deterministic or probabilistic – to quantify and map ecosystem services, at the appropriate spatial scales and specifically for each ecological and socio-economic context.

ESTIMAP[51] (Ecosystem Service Mapping Tool) is a GIS model-based approach to spatially quantify ecosystem services, developed to support ecosystem services policies at a European scale. It is a set of separate process-based models that assess the supply, demand and flow of different ecosystem services, for use within a GIS. Although developed at the European scale, the models can be downscaled to the local level. The nature-based recreation, pollination and air quality models are being used by several of the OpenNESS case studies and EnRoute CityLabs.

INVEST [52] (Integrated Valuation of Ecosystem Services and Trade-offs) provides an effective tool for exploring the likely outcomes of alternative management and climate scenarios and for evaluating trade-offs among sectors and services. A range of decision-makers, from government agencies through conservation organisations to corporations and utilities, can use the tool.

---

48 http://www.maes-explorer.eu
49 http://www.aboutvalues.net/
50 http://aries.integratedmodelling.org
51 http://publications.jrc.ec.europa.eu/repository/bitstream/JRC87585/lb-na-26474-en-n.pdf
52 https://naturalcapitalproject.stanford.edu

OPAL[53] (Offset Portfolio Analyser and Locator) is a free, open-source software tool that enables users to quantify the impacts of infrastructure development projects locally, and to assess the potential benefits of offset (i.e. mitigate in their terminology) for both ecosystem services and biodiversity. It aims to help impact assessment practitioners, policymakers, developers and others to evaluate the consequences of development projects and to design offset portfolios that equitably offset development projects being considered within a region or to assess alternative options for a particular project.

OPAL is designed to use commonly available ecological and social data. It includes modules to incorporate the results from InVEST carbon, sediment and nutrient retention ecosystem service models (see above), but can also use other ecosystem service models as inputs. See Mandle *et al.*, (2016) for more details.

It should be borne in mind that the use of sophisticated BES loss-gain metrics has some drawbacks, including their reduced transparency, especially if numerous subjective or arbitrary judgements are required (e.g. on habitat classes and values, appropriate baselines/benchmarks for habitat condition and weighting factors). These issues can undermine confidence in the system among stakeholders. On the other hand, simplistic metrics may also be subject to criticism, as for example in UK (England) where the biodiversity metric proposed by the government for use in trials was a simplified version of the habitat hectares approach, and more basic than recommended by many (Baker *et al.*, 2014). The more robust metrics also need sufficient data, which often requires detailed and lengthy fieldwork by experts (especially if species are involved), which can have significant cost implications; therefore, requirements for metrics and associated data should be proportionate to the potential risks and magnitude of biodiversity and ecosystem service losses.

When establishing offsetting schemes, authorities need to consider whether particular types or specific metrics should be used for biodiversity and each main ecosystem service type (e.g. based on the MAES framework). This is important because standardisation can improve clarity, consistency of use, leading to better application by project proponents, and checking by authorities and stakeholders, and easier comparisons of offsetting schemes and outcomes (especially if there are frequent exchanges). In Germany, many problems have arisen from the use of a wide variety of metrics, which have caused confusion and high transaction costs (Tucker *et al.*, 2014). But standardisation can also lead to a lowering of standards, possibly to an average or even simplest common methodology, rather than raising average standards.

As discussed in Section 4.3.1, whatever metrics are used need to be carefully combined with appropriate exchange rules. This is important because metrics do not capture all important biodiversity values and therefore a precautionary approach needs to be taken that guards against exchanges in habitat type that could lead to undetected biodiversity losses.

[53] https://naturalcapitalproject.stanford.edu/software/opal

Because the gains (credits) provided by offsets often take time to be established (often decades), it is common practice to adjust calculations of the amount of offsetting that is required using time preference multipliers (Bull *et al.*, 2017). These attempt to take into account possible temporary losses of benefits and stakeholders' normal preference for benefits sooner rather than later. Such multipliers are not normally applied to habitat banks that are able to provide credits from offsets that are already in place (see Section 4.5.3). However, constraints on advance credit release can be complex and habitat banks may not always be able to provide full credits in advance of impacts, so there may still be time delays before NNL is achieved. Therefore, it might be appropriate to apply time preference multipliers to habitat banks if it is likely that their values change with time (e.g. if releasing credits for a 5-year-old habitat scheme where it is demonstrated that the habitat is present, but has yet to deliver its functional value). However, clearly, offset measures should already be implemented and functioning before the impact takes place (see also Section 4.6).

4.4.2 Target-based offsetting

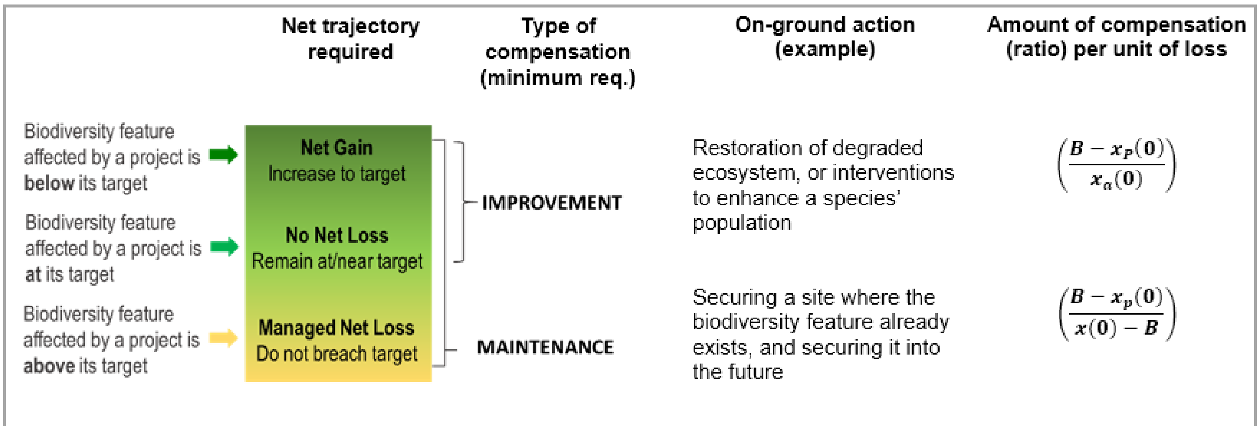
Simmonds *et al.* (2019) proposed a new framework for compensating for biodiversity losses from development in a way that is aligned with jurisdictional biodiversity targets. In this, the type (averted-risk or restoration offsetting) and amount of ecological compensation that is appropriate is calculated from the gap between the current state of biodiversity and quantitative time-bound targets set in spatial plans or biodiversity policy. The calculation ensures that projects contribute proportionately to the achievement of different targets, as would be expected in the context of spatial planning and SEA, in particular.

The approach requires:

- Outcomes-based biodiversity targets for specific biodiversity features (species populations, ecosystems), in a jurisdiction (e.g. national or sub-national). For example, a target for the number of breeding individuals of a threatened species might be a minimum of 10,000; a target for the area of a vegetation community in a region might be at least half of its original extent, in good condition.
- Estimates of the current state of the biodiversity feature (e.g. its area, or population size).
- The amount of the biodiversity feature that is, or will be, effectively secured (e.g. in protected areas).
- Regulatory control of at least some sectors that cause biodiversity loss through their activities.

With this information, the type and amount of compensation for every unit of loss can be determined, as indicated in **Figure 4-3**.

Figure 4-3 Overview of the proposed approach for calculating compensation requirements in relation to meeting biodiversity targets



B = Target; Xa(0) and X(0) = amount of biodiversity feature that can be lost at the time the policy established; Xp(0) = amount of biodiversity feature that is effectively protected at the time the policy established

Source: Early versions of Simmonds *et al.*, (2019)

Under this framework, the definition and sizing of offsets is streamlined:

- Ratios for specific biodiversity features are determined upfront, during development of a compensation policy – the ratios then apply consistently to all sectors that are regulated to compensate for residual losses (after strict application of the mitigation hierarchy).
- Other factors can modify the compensation ratios given by the formulas above – for example, building in uncertainty and risk into 'improvement' ratios (discussed below).

4.4.3 Dealing with uncertainty – the use of risk multipliers

The process of offsetting is not certain as there are risks of complete or partial failure to compensate for residual impacts. Therefore, in accordance with the precautionary principle, it is common best practice to apply multipliers to the results of loss-gain metrics when calculating the amount of offsetting that is required (Bull *et al.* 2017). The aim of such risk multipliers is to increase the basic size of an offset (as set by the underlying loss-gain metrics and underlying account model), to adjust for concerns that the offset may not be sufficient to deliver a NNL outcome. The calculation of appropriate risk multipliers should be based on empirical analysis (e.g. of offset failure rates, if they have been adequately monitored) or through consultations and negotiations with stakeholders with regard to distance and other equity issues. However, in practice multipliers are often generic rather than based on evidence of specific risks and mitigation measures (Gardner *et al.*, 2013). This is despite earlier research that indicated that for restoration offsets, the multipliers used are often too low (Moilanen *et al.*, 2009). If calculated appropriately (i.e. probability of failing to achieve NNL is minimised) very high multiplier ratios are often required to adequately adjust for risks (e.g. >1:100).

An important limitation of the use of multipliers to adjust for uncertainty is that they do not adequately address the risks of complete failure of a single offset, because the multiplication of area requirements will not affect the outcome. Therefore, it is also important to complement the use of risk multipliers with robust offset designs, monitoring and, where necessary, adaptive management. Also, where numerous offsets are to be carried out, some form of hedge betting, where a number of different offset solutions are carried out across a number of sites, can be a more effective way of guarding against the risks of widespread offsetting failures.

An effective way of guarding against offset failure, at least in the short term, is to require the offset to be carried out in advance of the impacts, so that the biodiversity or ecosystem service gains can be directly observed and measured. This can be achieved through requirements for individual offsets to be carried out in advance, for example, as part of a development permit, or through the use of established habitat banks to provide offsets (see Section 4.5.3).

4.4.4 Incorporating time lags into measurements

While calculations for predicting a new biodiversity state can be made in various ways (qualitative, semi-quantitative, quantitative), when and how fast this new state is attained matters for NNL. To address this, a particularly interesting approach is the Habitat Equivalence Analysis (HEA) approach (NOAA, 2006; REMEDE, 2008[54]). HEA is arguably the only scientifically-based quantitative framework currently available for evaluating NNL over time. HEA is a summation of the proportional change in biodiversity relative to the baseline situation, usually calculated annually, and discounted to the present value. The biodiversity lost or gained is summed over the period of interest, scaled to the reference habitat (i.e. a habitat condition metric), and multiplied by the number of hectares of the area. When this approach is used for scaling losses of fish, birds, and other wildlife, the method is sometimes referred to as Resource Equivalency Analysis (REA).

4.5 Deciding on where offsets should be located

4.5.1 On-site versus off-site considerations and offset combinations

Defining the area within which offsets can be located has significant implications for an offset scheme and its potential impacts. International experience indicates that there is often a preference for on-site restoration and offsetting, with off-site delivery being discouraged and only undertaken as a last resort. This is because local offsets often provide greater confidence that equivalence will be achieved, especially the maintenance of spatially connected functions (e.g. connecting habitats, or providing local cultural services), and that those affected by the project will benefit from the offset. But this is sometimes not ecologically appropriate, especially as the project that created the demand for the offset may also have impacts on the offset. For example, a pond created as an offset alongside a

---

[54] REMEDE (Resource Equivalency Methods for Assessing Environmental Damage) http://www.envliability.eu/pages/publications.htm

road that destroyed the original pond may be affected by run-off and high mortality of animals moving to and from it across the adjacent road (so may be a sink habitat).

Requirements for offsets to be near to the impacted site can also create supply-side constraints where suitable sites are lacking. For instance, in Germany a legal requirement for on-site offsets to be carried out if feasible made it difficult to carry out offsets in practice, which resulted in the law being relaxed. The need for more flexibility in allowing offsets to be delivered away from an impacted site is being increasingly recognised. Moreover, if a more strategic approach is taken, where offsets are delivered where they are needed most in a landscape context, the biodiversity and ecosystem service benefits may actually be greater (Kiesecker *et al.*, 2009; Kiesecker *et al.*, 2010). For example, judicially placed offsets may provide added landscape-scale benefits by:

- increasing the size of habitat patches to make them more resilient and increase the viability of their species populations;
- buffering habitat patches (e.g. protected areas) from external impacts (e.g. pollution, disturbance);
- joining up isolated habitat patches (e.g. corridors or stepping stone habitat patches); and
- creating other forms of green infrastructure that can supply ecosystem services.

It is therefore important to consider all on-site and off-site options, their various advantages and disadvantages (considering likely future developments), and their overall outcome, taking into account the exchange rules and requirement for equivalence. For biodiversity, the offset location needs to be of ecological relevance, **not** simply within the administrative region. Instead, a more appropriate approach is to use bio-geographically defined regions as the service area, thereby adopting a similar approach to water basins and river basin management. Such an approach is used in Germany, where natural areas have been identified and offsets must be within the same natural area as the impacted site (see Section 4.5.2). Key considerations on keeping offsets local whilst contributing to strategic priorities are outlined in Baker *et al.*, (2019).

Where offsetting is required for particular species it should address the same population (rather than a defined area), and consider meta-population structures if necessary (van Teeffelen *et al.*, 2014). Thus, offsets might be located to provide strategic ecological benefits, such as joining up isolated populations (e.g. contributing to habitat restoration/recreation measures identified in species action plans). For migratory species, it might even be ecologically feasible to carry out offsets in other countries. However, this could raise potential problems with regard to political acceptability and regulatory enforcement.

In contrast, with ecosystem services (other than carbon sequestration) it is often more important to ensure that local benefits and issues of social equity are not overlooked, as for example occurred in the USA, where wetland offsetting resulted in a redistribution of wetlands from urban to rural areas (Ruhl and Salzman, 2006). Thus, as discussed in Section 2.4 it is necessary to ensure NNL of supply and benefit (Sonter *et al.*, 2019), by providing the same benefit to the same people within a defined 'service shed' (Tallis and Polasky, 2009). The extent of a service shed is determined by the area that supports the biophysical service and allows beneficiaries both physical and institutional access to the service. Bull *et al.*, (2018) provide guidance and good practice examples on dealing with social issues in relation to offsetting and other NNL activities.

A further complication to consider is that there may be potential conflicts or synergies within offsets with respect to achieving multiple NNL objectives. Thus, for example, a common requirement of biodiversity offsets is undisturbed habitat, which could then therefore conflict with the requirement through the creation of green space for recreation. Such conflicts may therefore lead to trade-offs, especially where offsets attempt to meet many objectives, and these can be difficult to identify and manage, potentially meaning that the offset is unsuccessful in achieving some NNL objectives, without further offsets (Bull *et al.*, 2018; Sonter *et al.*, 2019).

As further discussed by Sonter et al (2019), it is therefore necessary to consider the potential links between biodiversity and ecosystem services in deciding on the potential options for combining NNL objectives within one or more offsets. Once such links have been identified, then there are broadly speaking three approaches to addressing NNL objectives:

- **Independent offsets** (or composite offsets) – where each biodiversity and ecosystem service loss is offset independently across a range of sites.
- **Bundling** – where a single site is used to offset multiple losses from a development that are combined and sold as a single package to the developer.
- **Stacking** – where a single site is used to provide offsets for multiple biodiversity and ecosystem service losses and/or developments that are sold separately.

The advantage of the independent or composite offsets is that it has a relatively simple and reliable accounting approach, and may often be the most feasible and equitable in practice. For example, it enables biodiversity components with local needs and values to local communities to be conserved through offset activities near the area of impact, while simultaneously enabling biodiversity offsets further afield where they may be able to provide greater benefits (e.g. for higher priority habitats and species, or in strategically beneficial locations). An advantage of bundling is that it is more efficient in terms of using fewer sites, and getting higher quality, and can benefit from synergies between offsetting objectives, if they occur. However, in many cases conflicts between offset requirements may occur, and it may be very difficult to find suitable sites that are able to avoid this and meet all NNL requirements. Stacking is also potentially efficient, and may take advantage of synergies if they arise between NNL objectives. But a major problem with stacking is that it is difficult to determine whether each NNL objective is achieved through additional offset interventions, because it is unclear whether the provision of one type of benefit is inseparable from the provision of another (Fox *et al.*, 2011; Robertson *et al.* 2014; von Hase and Cassin, 2018). As a result of these various issues, Sonter *et al.* (2019), conclude that 'a judicious combination of bundling of some services (for which synergies are likely), and independent trades for the remainder, may therefore be the most effective approach'. Further and more recent discussion of the theory and practice of stacking and bundling ecosystem goods and services is provided in a BBOP resource paper (von Hase and Cassin, 2018).

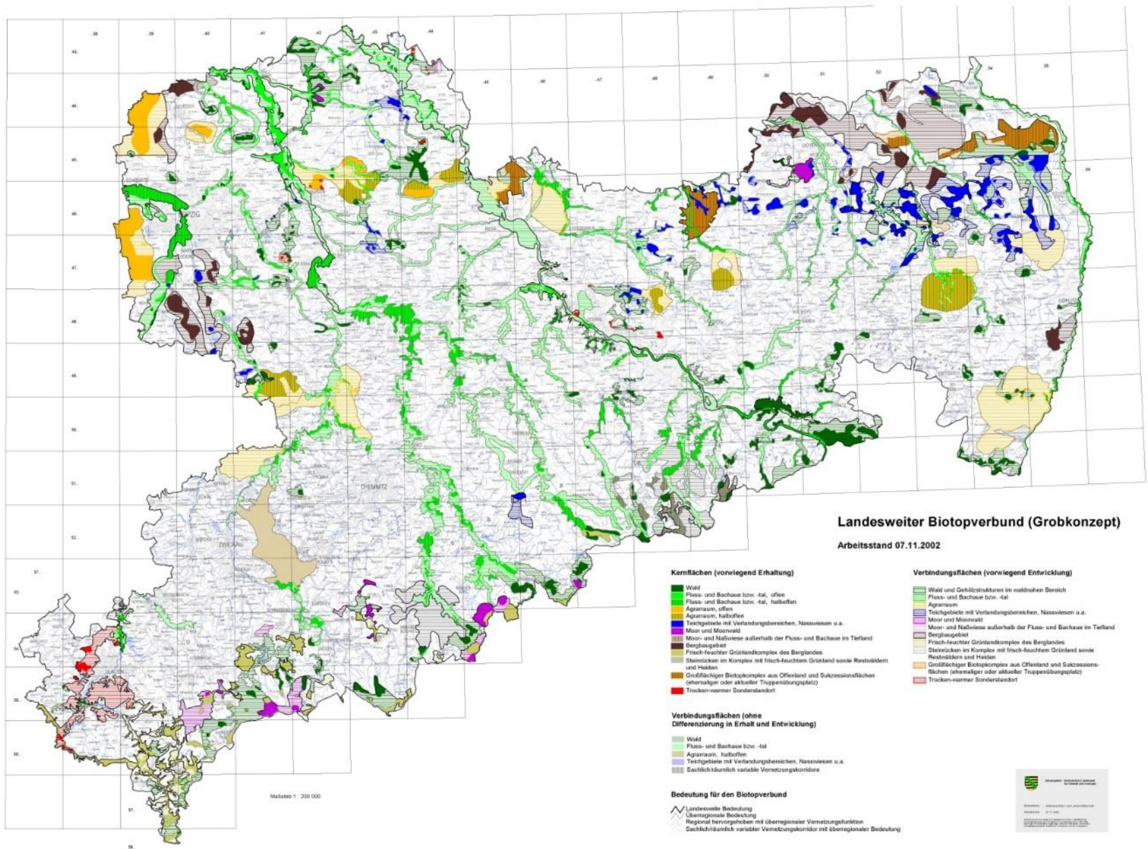
4.5.2 Locating offsets strategically in a landscape context: German examples at various spatial levels

To help ensure that offsets maximise their potential strategic added value, it is generally recognised to be good practice to target offset locations through links to spatial plans. For example, the BBOP principles state that: 'A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes, taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.' Hence, the guiding question is: what kind of planning instruments are applicable in this landscape context and which planning level has to be addressed? The following examples from Germany provide some lessons that may be more widely applicable.

Regional planning

At the regional level of spatial planning, most of Germany's constituent states draw up their own landscape programmes. These programmes include provisions for the protection or development of regional biotope networks. **Figure 4-4** shows an example of a draft planning concept for the State of Saxony, given legal force by integration into Saxony's regional planning while taking into account other issues and interests. Regional planning safeguards the corridors shown, for example by designating these as *Vorranggebiete* (priority areas) for nature conservation. This prohibits any activity that develops the land, for example economically, which is incompatible with nature protection goals. When the concept becomes legally binding, the ecological network is created using funding from public nature conservation programmes and by integrating biodiversity offsets. This shows how legally binding planning concepts at the levels of regional spatial and landscape planning can increase the success of biodiversity offsets (Grimm, Köppel and Geißler, 2019). At the same time, attention is given to ensuring each biodiversity offset is implemented in such a way as to ensure a bio-geographical connection between the area of impact and the area of compensation.

Figure 4-4: Example of a landscape programme aiming to create and/or restore a habitat network for the Federal State of Saxony



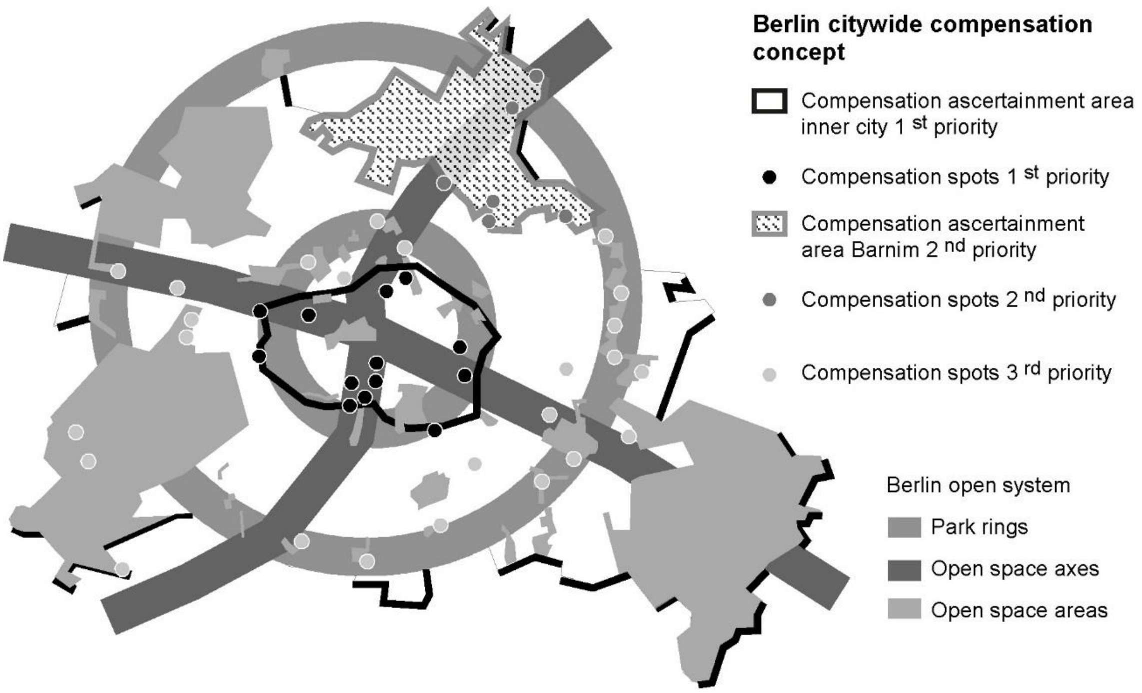
Source: Sächsische Landesregierung, draft from 2002.

City/urban planning

The following example of sustainable urban planning in Berlin visualises a general offset strategy at a citywide level in the context of urban ecosystem services and/or urban biodiversity (**Figure 4-5**, see also Wende and Darbi, 2018). In order to consolidate and manage compensation measures, the Berlin Senate Department for Urban Development has developed a General Urban Mitigation Plan to complement the Berlin Landscape Program 2004. Development objectives and measures are grouped according to the type of impact and type of compensatory measure. From the city perspective, areas and measures are prioritised when they qualify and complement components of Berlin's open space system. Special priority is given to measures that improve the quality of the inner city. Compensation areas of secondary priority are those within the green and open-space system of the Berlin-Barnim Recreation Area in the northeast of the city. Two further compensation ascertainment areas or wider-level compensation areas are still to be developed and completed: the Green Axis Cross and the Inner and Outer Park Rings, where tertiary-priority compensation areas are located.

Generally, these areas are selected for their demonstrable potential to improve the environment and strengthen conservation. In cases of structural interventions in the urban open space as well as environmental impacts, compensation measures are now to be developed according to this basic offset strategy. The respective 'perpetrator' of the impacts (generally a private investor) must bear the costs for these measures, which are documented in the Berlin register of compensation areas maintained by the Senate Department for Urban Development. The intention is to safeguard environmental and nature-improvement measures for the long term.

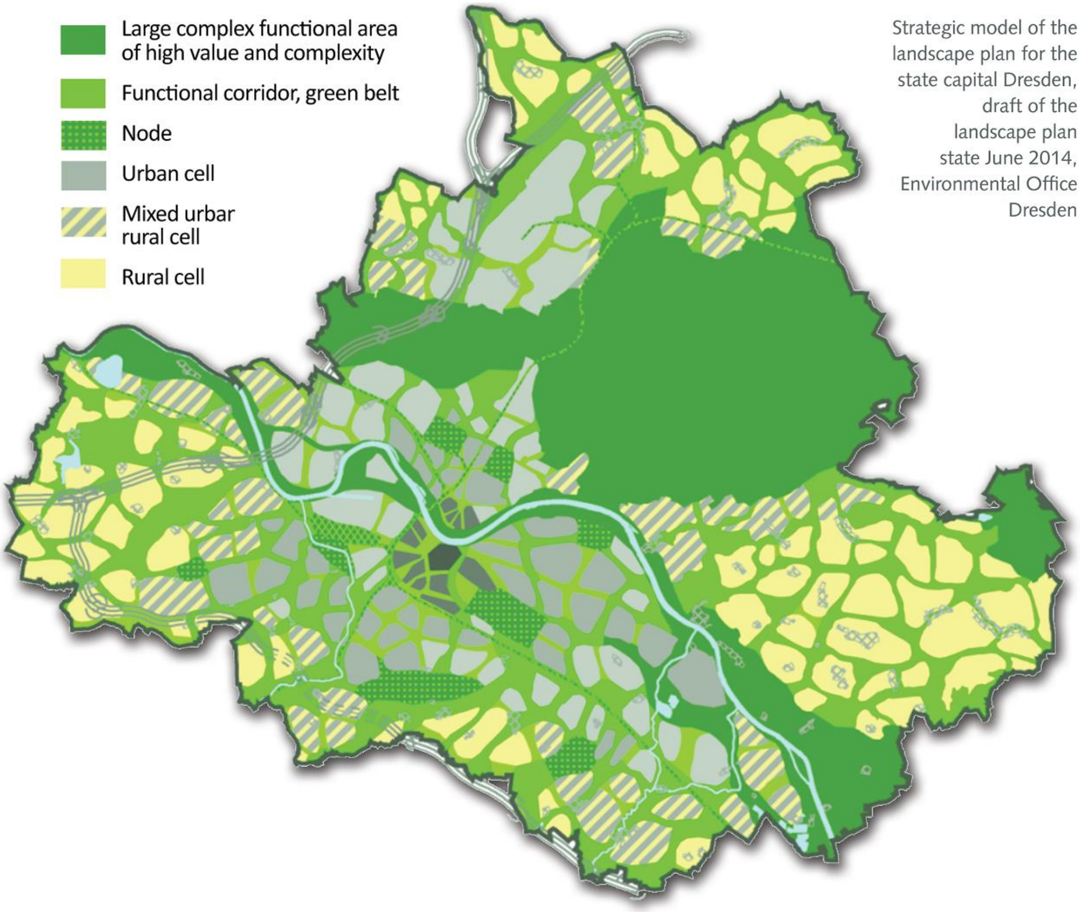
Figure 4-5: Berlin citywide compensation concept



Source: Senatsverwaltung für Stadtentwicklung und Umwelt Berlin (2004, translated).

Another citywide example is the Municipal Landscape Plan (Draft) of the City of Dresden (**Figure 4-6**), which follows the *Leitbild* (vision) of a 'compact city within an ecological network' and can be regarded as an overall urban spatial strategy. Again, this landscape plan is validated through integration into the legally-binding urban and land-use zoning plan. The concept helps in determining where, for example, biodiversity offset measures should be applied or concentrated in order to realise the *Leitbild*. In this way, city-level planning can ensure the success of compensation measures.

Figure 4-6: The 'Leitbild' (overall concept) of 'Dresden: the compact city in an ecological network'; draft landscape plan for Dresden



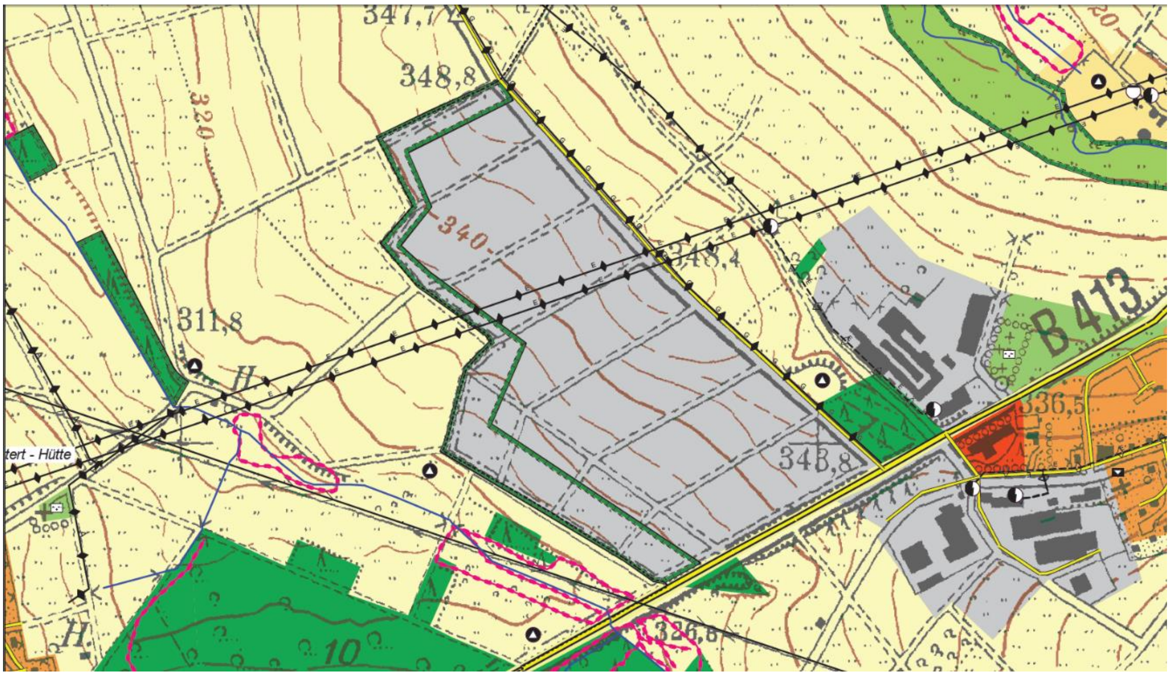
Source: LH Dresden, after LandschaftsArchitekt Paul. See also Wende (2019), p. 157.

Local level

At the local level, Germany's municipalities can also make use of spatial plans to secure sites for biodiversity offsets. This can be achieved through the application of the Building Law. Normally, sites reserved for the compensation and offset of interventions in BES are delimited by a so-called T-line. **Figure 4-7** is an extract from a local land-use zoning plan, including the designation of reserved sites. The areas shown in grey are to be developed as a business park. However, within these areas the green T-lines indicate sites which are to be safeguarded for compensation and offset measures.

These examples underline the importance of incorporating offsets into the full range of planning levels from the regional level down to the local level. Only in this way can compensation be fully integrated into a country's system of spatial planning.

Figure 4-7: Land Use Zoning Plan for the municipality of Kundert and Hachenburg, Germany



Notes: Sites reserved for biodiversity offsets are highlighted in green (note, in particular, the green T-line, the green-bordered part of the grey polygon rather than the green shaded ones)

4.5.3 Pooling offsets / habitat banks

As indicated above, there may often be advantages from combining offsets in the same area or within a targeted zone to help create landscape-scale benefits. This can be achieved by encouraging developers to place offsets in targeted areas (e.g. those identified in spatial plans, creating a pooling of offsets) such as by weighting offset metrics accordingly, or by making it a mandatory requirement.

Another approach is to create habitat banks (also known as biodiversity/conservation banks). Habitat banking is the creation of a market for offsets, such that the credits from the biodiversity gains from a bank can be purchased to offset the debit from biodiversity losses (Carroll, Fox and Bayon, 2008; Briggs, Hill and Gillespie, 2009; Burgin, 2010; EFTEC and IEEP, 2010; Conway *et al*., 2013). Credits can be produced in advance of, and without ex-ante links to, the debits they compensate for, and stored over time. One benefit of habitat banks is that they often result in the pooling of offset credits to produce large areas of habitat, because this reduces their unit cost of restoration and management.

Habitat banking has a long history and has been popular in the USA, with about 450,000 hectares of wetland being under the permanent protection of a habitat bank by 2011 (Becca *et al.*, 2011). Initially, it started as a governmental initiative, but currently 70% of habitat banks are privately owned (Schoukens, 2015). This differs significantly from Germany, where approximately 80% of the so-called ‘eco-pools’ are owned by a public party. Habitat banking in the USA is often referred to as ‘commercial’ as it mainly rests in private initiatives, while German habitat banks are often the result of public initiatives. ‘Commercial’ does not, however, mean that it is unregulated. Both German and American habitat banks are under governmental supervision, requiring the fulfilment of ecological conditions of the selected site and its surroundings, a solid management plan of the area, and arrangements to guarantee permanent execution of this plan (Schoukens, 2015).

Habitat banks can have a number of advantages over conventional single offsets, including:

- more effective, and in some cases ex-ante (and therefore more reliable), delivery of existing biodiversity policy objectives and of compensation requirements;
- increased ecological quality and resilience of large-scale measures (also potentially from pooled offsets)[55];
- increasing ecological connectivity (e.g. linking up and increasing the size of small habitats, or buffering Natura 2000 sites), green infrastructure and ecosystem service benefits through strategic and selective placement of compensation measures, especially if linked to spatial planning, ecological network and green infrastructure strategies;
- the ability to efficiently address cumulative impacts from individually small-scale or low-level impact developments for which there is no legal requirement for compensation;
- providing a simpler system for project proponents, which can reduce delays in getting project permits (and so changes ecological risk into a business risk);
- integrating local farmers and other landowners into maintenance measures and thereby creating new economic opportunities;
- providing credits in advance, which can also speed up decision-making and reduces uncertainty and time lags so it may be possible to avoid the use of time and risk multipliers (see above), thereby greatly reducing the required offset area; and.
- reducing costs due to economies of scale and simpler processes (e.g. off-the-shelf credits) that lower transaction costs.

However, habitat banking requires a high demand for offsetting, and therefore a market, which will normally need to be stimulated by a regulation (EFTEC and IEEP, 2010; Hansjürgens *et al.*, 2010; Conway *et al.*, 2013). Therefore, habitat banks are only likely to function for certain habitats or ecosystem services that are under widespread threat (creating the demand) and relatively easy to offset (providing the supply). As a result,

[55] The collective organisation of resources to deliver compensation requirements for debits from more than one source, usually ex-post of damage. They have some features of habitat banking (like economies of scale), but not others (they do not produce a market for the supply credits and are not effective ex-ante).

exchange rules that narrowly define habitats into many types and have strict in-kind requirements can constrain the banking market, such that it may not be economically viable.

Habitat banking also has its own risks, as well as the generic risks of offsetting, including the potential aggregation of a high proportion of offsets in one bank (Levrel *et al.* 2017). This undermines the concept behind the use of multipliers to a deal with failure risks, which assume that offsets are independent and as a whole will be sufficient. Habitat banks require specialist knowledge and considerable investments to establish, which may lead to monopolies, for example in a region, and therefore may not provide value for money if they are the only offset option. To address these and other offsetting risks, it is important that habitat banks are closely regulated and have high-quality standards. This challenge was identified as a key impediment to rolling-out habitat banking in Spain (Maestre-Andrés *et al.*, 2020). Such standards, however, restrict the 'market' for habitat banks, and this may explain the slow growth of habitat banks in France: since these were legalised in 2016, no new banks have been registered beyond two of the initial pilot operations.

Box 4-5 provides an example of the voluntary quality standards for habitat banks in Germany.

Box 4-5: Voluntary quality standards for habitat banks in Germany

According to the voluntary quality standards of the German Association of Compensation Agencies (BFAD), habitat banks (i.e. eco-pools) have to:

- deliver ecological improvements rather than simply maintaining an existing level, even if this is of high ecological value;
- be secured for long periods of time: with sites normally secured for an unlimited period and measures for at least 25-30 years[56]. This must be ensured by appropriate treaties and requires financial backing;
- proper documentation of the condition of habitat banks before the project launch as well as the effects of measures over time (for example, impacts after 5, 10, 15 and 25 years); and
- take into account regional spatial and landscape planning as well as other relevant ecological plans and programmes (see von Haaren *et al.*, 2019).

4.6 Deciding on when offsets should be delivered

To avoid temporary BES impacts **offsets should be in place before the development impact occurs**. This is essential if the impact would result in critical losses that cannot be reversed, so that temporary impacts become permanent losses, especially if they lead to local or wider extinctions (e.g. of endangered or isolated species populations). However, this may

[56] The timeframe of 25-30 years is in relation to active management measures, their funding and safeguarding by those parties responsible for the impacts and/or the habitat bank. After this period, the site may be regarded as ecologically valuable, requiring further care or at least protection for more years.

not always be possible, because the conservation gains of an offset are often uncertain and may require many years to achieve.

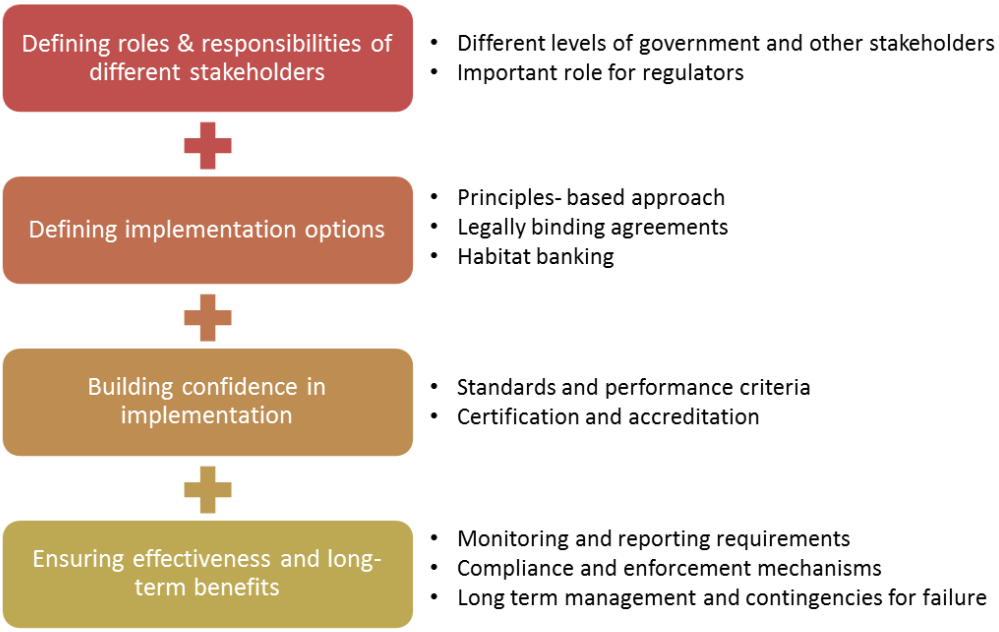
Habitat banking schemes, as a means of delivering biodiversity offsets, may help address concerns over interim losses to some extent by achieving some progress in delivering conservation gains prior to the impact taking place. However, habitat banks can also release at least some of their credits at an early stage, when significant uncertainties about future outcomes still remain. Given the time taken to establish effective habitat banking arrangements, a requirement for compensation to be fully operational prior to a project taking place may be unduly restrictive, especially in the case of new offset policies for which there may not be an established supply of offsets or habitat banking arrangements. An offset scheme could therefore take a flexible approach, similar to that seen in Australia and the USA. For example, in Victoria, Australia, temporal issues are factored into scoring, depending on when offsets are initiated. On the other hand, US wetland mitigation banking allows for credit releases in accordance with the achievement of specific milestones (Vaissière and Levrel 2015).

Another way to indirectly address interim losses is to add time preference multipliers into the loss-gain metrics and calculations of the required amount of offsets. However, while this may be appropriate for some ecosystem services (where communities accept increased offsets in recompense for interim losses) it is not really a solution for biodiversity. Therefore, if interim losses are likely to affect biodiversity of high-level importance, it should be acknowledged that offsetting is not a solution and the acceptability of the development project should be reconsidered.

4.7 Implementation arrangements

As well as the need to define appropriate offset design requirements, the achievement of NNL is also dependent on the complete and effective implementation of the offset, which requires careful consideration of a number of important issues (summarised in **Figure 4-8**). This guidance therefore provides some recommendations for authorities and other actors that may be involved in the establishment or ongoing management of offsetting schemes.

Figure 4-8: Key implementation arrangements for biodiversity offsetting



Where offsetting schemes are to be established it is recommended that an **Offsetting Implementation Plan** is developed to prepare for, initiate, roll out and support offsetting measures. Tucker *et al.* (2014) suggest that such plans should clearly describe and allocate responsibilities and milestones for actions that:

- complete the policy/regulatory framework;
- prepare and distribute operational guidance for the policy;
- ensure offset suppliers are sufficiently established to meet the new demands that will be triggered by the policy and regulations;
- initiate pilot projects to test and provide lessons that can be used to continuously improve the system;
- establish the required capacity for regulators, assessors, suppliers and others to implement the system;
- create and develop required institutions (e.g. brokers, registries etc); and
- define procedures and standards for monitoring, evaluation and enforcement.

4.8 Defining roles and responsibilities for different stakeholders

In order for an offset scheme to be effective, it is vital that the different roles of actors are clearly defined. This includes, for instance, responsibility for regulation, monitoring and enforcement; certification of suppliers; provision of offsets and habitat banking services;

and oversight of market transactions for offsets or credits. Within this context, regulators have a key role to play to ensure that requirements are properly met and adhered to, and in defining standards and performance indicators. There is also a need to consider multi-level governance, and to determine what is best done at what level and where responsibility for different aspects should be placed (e.g. EU, regional, national and local level).

4.9 Defining implementation options

An important decision that needs to be taken with respect to offsetting policies and regulations is what implementation options to allow for. Regulatory frameworks for biodiversity offsets commonly offer developers a range of options as to how to fulfil their offset obligations in terms of implementation. Lessons from several countries show that it is important to consider potential unintended consequences and perverse incentives that may arise from offset frameworks (ten Kate, 2014).

The basic model carried out is bespoke, **project-specific offsets**, which are designed to ensure NNL arises from a particular project or programme (or potentially organisation). These may be carried out by the project proponent (i.e. permittee-led), which could be a private business (e.g. house builder, mineral extraction company) or public body (e.g. municipality, water, transport or energy authority). Or a third party may provide the offset, such as a private consultancy or NGO. The other main way of implementing offsets is through **habitat banking systems**, as described above in Section 4.5.3. These are mostly established by public authorities with large offsetting needs (e.g. municipalities, transport or flood management authorities) or by private businesses. A third, less common, approach is to allow **fee-in-lieu schemes** that pool payments (e.g. equivalent to the cost of replacing lost BES), for instance through a governmental institution or appointed body or via an independent environmental trust fund, and use these to provide measured BES benefits. These do not ensure NNL from a specific project or development, but can be designed and regulated such that they offset losses collectively (e.g. at the regional or sectoral level).

The three implementation options have a variety of advantages and disadvantages, which were summarised in a Commission study based on reviews of international experience (**Table 4-2**). This shows that, in general, project-specific offsets are the most straightforward and easiest to carry out and monitor, and in some respect have the lowest risk. They should therefore normally be used for offsets of high-value habitats and ecosystem services that require carefully planned bespoke designs.

Habitat banks can be effective in reducing offsetting costs and risks of offset failure, and increasing the strategic landscape-scale benefits of offsetting. They may also deliver their offset benefits (credits) in advance of the impacts, thereby avoiding interim biodiversity losses – although biodiversity benefits may take a long time to be fully realised. These advantages may make offsetting schemes more acceptable to nature conservation and business stakeholders. However, they require clear offsetting regulations, sophisticated governance and substantial oversight to stimulate demand and to ensure they meet NNL objectives. They are unsuitable for offsetting habitats, species and ecosystem services that rare, specialist or infrequently impacted (i.e. with low offsetting demand).

Fee-in-lieu systems are most suitable for habitats and ecosystem services of relatively low importance for which the transaction costs of other offsetting systems would be too high to justify offsetting – thus they can be an efficient means of extending NNL objectives to ordinary BES. In addition, the pooled funds can be used to target restoration/creation to the most important habitats and ecosystem services, and place offsets in locations that provide the highest added value, for example, in landscape terms. However, previous experience from their application in the USA indicates that they performed poorly for a number of reasons, including low standards being applied to the agencies undertaking them, a lack of enforcement; slow disbursement of funds and difficulties show additionality when governments take over offset activities (IUCN, 2014). But it should be noted that such schemes do not necessarily have to involve governmental authorities, and could incorporate safeguards to deal with the other problems encountered so far.

Table 4-2: Summary of the advantages and disadvantages of the main offsetting delivery systems

Offset system	Advantages	Disadvantages
Bespoke project-specific offsets	• Clear linkage between impacts and offset gains. • Simplest governance structure. • Enables project proponents to carry out their own offsetting if desired, which may be cost-effective for some. • Avoids breaks in liabilities for NNL outcomes from developers to third parties. • Market provision of offsets may drive down costs, thereby increasing acceptability to project proponents and efficiency.	• Credits based on expected outcomes and therefore unreliable, and thus monitoring and contingency measures are required. • Individual offsets may be too small to be effective or viable. • Limited ability to influence location of offsets as market driven (i.e. often on lowest value land). • Commercial pressures and public spending rules result in purchase of cheapest offsets, which normally only meet minimum legal standards.
Habitat banking	• Pooling of offsets creates larger areas of higher ecological value, which can be encouraged (e.g. through metric multipliers) to occur in strategically beneficial locations. • Market provision and pooling of offsets may drive down costs, thereby increasing acceptability to project proponents and efficiency. • Moderately simple governance structure. • In some cases, credits are provided in advance of debits, thus removing the	• Ability to influence location of offsets is based on simple incentives which may no longer reflect priorities by the time credits are sold. • Commercial pressures and public spending rules result in purchase of cheapest offsets, which normally only meet minimum legal standards.

Offset system	Advantages	Disadvantages
	risk of initial failure, which can avoid interim losses, reduce offset need, and facilitate quick permitting.	
Fee-in-lieu payments to environmental trusts	• Funds are pooled to ensure offsets are of a viable size. • Decision on use of funds is made by experts and stakeholders and not project proponents, so overriding incentive for trust members is to maximise value for money and long-term benefits, i.e. **not** obtaining the lowest cost acceptable offset. • Choice and location of habitats and species measures can react to changes in priorities (e.g. in response to previous measures and other environmental changes). • Low transaction costs enable system to be applied to low biodiversity impacts. • Can utilise habitat banks if appropriate and thereby benefit from their advantages.	• Loses clear link between impacts and offset gains. • Amount paid may not be as closely tied to metrics designed to achieve NNL as other methods. • Transfers burden of responsibility for measuring and achieving NNL from project to scheme level – which may be a disadvantage in some cases. • Requires a relatively complex governance structure • Possible conflicts of interest among trust members (e.g. regarding use of funds and possible objections to developments that they could gain from). • Cost of habitat replacement can be difficult to calculate and varies from place to place. • Financial risks of miscalculation of replacements costs is transferred from the developer to the scheme, which could cause shifts in objectives and failure to achieve NNL. • Direct nature of charging system may be seen as an unpopular tax on development.

Source: Tucker *et al.* (2014).

4.10 Building confidence in implementation

Regardless of what sort of offset is allowed it is essential that third party bodies (e.g. governmental authorities/agencies, or consultants appointed by them) **check that offsets are carried out and that impacts and credits are as expected**. BBOP recommends that monitoring should cover implementation performance (i.e. the process, covering inputs, activities and outputs) as well the impact performance (i.e. ecological and biodiversity impacts). Monitoring is also mandatory, as required by the EIA Directive. This process needs to be transparent and publicly reported, so that stakeholders can be involved, see what is happening and, if necessary raise concerns.

Public participation plays a prominent role during the whole planning process and decision-making. During the planning process, public and local nature conservation NGOs should be involved while drafting any offset implementation plan. This also helps to develop long-term acceptance of the offset measures and create a sense of ownership towards local biodiversity and nature conservation activities. Engagement by stakeholders can help to fill knowledge gaps by providing locally held information (e.g. through participatory mapping) on the supply and demand of ecosystem services, or local input into valuations. When analysing trade-offs, informed stakeholder discussions are an important basis for taking a decision. Support for implementation will also depend on whether stakeholders consider that their interests have been addressed in a balanced and fair way. Enabling stakeholder engagement is a crucial and complex process requiring appropriate attention and expert advice, as well as time and resources.

Offsetting **standards and performance criteria** are needed to ensure implementation is effective, particularly where there is a principles-based and comparatively flexible approach to offsets. These should establish the benefits expected of the offsets and provide a benchmark for monitoring. Administrative and ecological performance standards can be included in mitigation or management plans, with the ecological performance standards being linked to credit release schedules.

Certification and accreditation are often core to standards-based approaches, as they help to build confidence in offset provision. There are also benefits to the developer and/or provider, in terms of its license to operate and/or reputational advantages. The use of a certified pool can reduce the amount of compensation required. A range of mechanisms are available to implement certification. For instance, a habitat bank itself can be certified, and/or the consultants involved in designing and implementing the offset can be accredited.

The Habitat Bank of Finland[57] is a noteworthy umbrella project analysing, developing and piloting the principles of ecological compensation in practice. The project aims to provide science-based understanding and guidelines for a new market-based mechanism for biodiversity conservation, to complement the existing policy instrument mix. The new mechanism is urgently needed, as the existing instruments have not halted biodiversity loss.

Where offsets are not carried out there is clearly a need for **enforcement mechanisms**, such as fines or other penalties, to ensure that the offset is implemented. This element is critical, as the ability of relevant bodies to discharge their enforcement obligations is linked to the efficacy of legislation and the financial and resourcing capacity of regulating bodies. Without adequate enforcement, it is highly unlikely that an offsetting scheme will be effective. If offsets are implemented but fail to provide the expected gains (i.e. NNL is not achieved), then **contingency plans** should be enacted. For example, in Germany, authorities have the power under the Federal Nature Conservation Act to request a security up to the value of the offset. For habitat banks, it may also be necessary to establish provisions for bankruptcy or guidelines on how to avoid financial failure.

[57] https://blogs.helsinki.fi/habitaattipankki

Given the largely limited experience with biodiversity offsets in most Member States, and the different elements that are required for an offset scheme to be successful, there will often be a need for a programme of **capacity building** to overcome these constraints in order for a NNL initiative to operate smoothly. Such capacity building will be required to support regulators and governments, but also other stakeholders who are likely to be involved, including developers, companies, banks, consultants and NGOs. ten Kate (2014) reviewed biodiversity offsetting experiences and identified a number of key capacity constraints that normally need to be tackled (see **Box 4-6:**).

Box 4-6: Common capacity constraints affecting offsetting

- The understanding of governments which do not yet have offset systems in place as to how these work at the national and state level is limited, as is their understanding of the time involved in development of these systems. In addition, some governments (mostly in developing and least developed countries) struggle with the regulation of planning and environmental impact assessment, let alone NNL.
- The capacity of consultants and NGOs to undertake baseline studies, risk assessments for non-offset ability, loss-gain calculations and design of feasible offset activities and management plans remains limited.
- Companies sometimes fail to commission baseline work early enough or to an adequate standard. They can also struggle to coordinate internally or work adequately with joint venture partners, contractors and agents.
- Banks have limited in-house capacity to assess biodiversity risks or to screen consultants for appropriate skills if they intend to outsource some of this research.
- Biodiversity **data** are sometimes inadequate to support offset planning. Consistent, adequate data sets may not exist at the national or regional levels in countries (to serve as the basis for landscape level planning, definition of the 'exchange rules' to define 'like for like or better' and to set the benchmarks and attributes for metrics to calculate residual losses and offsets' gains). Some datasets are at a very coarse scale which needs more refinement to support the fine-scale conservation planning needed for offsets. Furthermore, some seasonality data are missing (and project timelines are sometimes too short to enable data to be collected over a number of years), and some taxa are poorly known and need further work (for instances, some freshwater species).

Source: ten Kate (2014).

4.11 Ensuring effectiveness and long-term benefits

Securing long-term conservation benefits from offset schemes relies on at least three main factors being satisfied:

- ensuring the effective delivery of conservation management activities through appropriate regulatory and management systems;
- securing the long-term use of land for conservation purposes; and
- ensuring the financial sustainability of conservation management over time.

Guidance on how these requirements may be met is provided by Rayment *et al.*, (2014) based on a review of international best practices. In summary, it is recommend that offsets should:

- be based on a **binding contractual agreement**, which is a condition of the permit for the development, and specifies the key conditions that need to be complied with (e.g. regarding management actions, monitoring, reporting, financial aspects) and are enforceable by the regulator;
- involve a **long-term management plan** (specifying required actions, performance standards and targets, monitoring and reporting arrangements), adherence to which is likely to be a condition of the contract;
- **secure rights to manage the land for conservation purposes**, most likely through purchase of that land, although long-term leases or long-term management agreements specifying conservation actions are a possibility (although they do not offer the same levels of long term security);.
- **involve obligations to use the land for conservation purposes** in the long term/safeguards against changes in use (e.g. a covenant or easement, involvement of a third party such as an NGO committed to conservation use, or long-term regulatory oversight/public scrutiny, perhaps backed up by information tools such as registers which specify that the land is to be used for conservation purposes);
- demonstrate **secure access to finance to fund conservation action,** normally by requiring establishment of an appropriate conservation fund, though there may be alternatives (such as a bank guarantee); and
- **provide safeguards against risk of failure** (e.g. use of a risk multiplier that allows for a certain percentage of failure, regulatory measures, contingency funds, and/or financial insurance).

5 REFERENCES

Albrecht, J., Schumacher, J. and Wende, W. (2014) The German Impact-Mitigation Regulation – A Model for the EU's No-net-loss Strategy and Biodiversity Offsets? *Environmental Policy and Law,* 44 (3), 317-324.

Alliance Environnement and Thünen-Institut (2017) *Evaluation Study of the Payment for Agricultural Practices Beneficial for the Climate and the Environment*. Alliance Environnement, Brussels.

Almenar, J.B., Rugani, B., Geneletti, D., and Brewer, T. (2018) Integration of Ecosystem Services into a Conceptual Spatial Planning Framework Based on a Landscape Ecology Perspective. *Landscape Ecology*, 33(12), 2047-2059.

Almenar, J.B., Bolowich, A., Elliot, T., Geneletti, D., Sonnemann, G., and Rugani, B. (2019) Assessing Habitat Loss, Fragmentation and Ecological Connectivity in Luxembourg to Support Spatial Planning. *Landscape and Urban Planning*, 189, 335-351.

Anne-Charlotte, V. and Harold, L. (2015) Biodiversity offset markets: What are they really? An empirical approach to wetland mitigation banking. *Ecological Economics*, *110*, 81-88.

APEM Ltd (2015) *Assessment of Displacement Impacts of Offshore Windfarms and other Human Activities on Red-throated Divers and Alcids*. Natural England Commissioned Report NECR227, England.

Artmann, M. (2018) Austria. In Wende, W., Tucker, G.M., Quétier, F., Rayment, M., and Darbi, M. (eds.) *Biodiversity Offsets – European Perspectives on No Net Loss of Biodiversity and Ecosystem Services*, pp.27-53. Springer Cham.

Baker, J., Sheate, W. R., Phillips, P. and Eales, R. (2013) Ecosystem services in environmental assessment—help or hindrance?. *Environmental Impact Assessment Review*, *40*, 3-13.

Baker, J., Sheate, W.R., Bennett, T., Payne, D., Tucker, G.M., White, O., and Forrest, S. (2014) *Evaluation of the Biodiversity Offsetting Pilot Programme. Final Report Volume 1*. Report to Defra project code: WC 1051, Collingwood Environmental Planning and IEEP, London.

Baker, J., Hoskin, R. and Butterworth, T. (2019) *Biodiversity net gain. Good practice principles for development*. CIRIA, London.

BBOP (2012a) *Biodiversity Offset Design Handbook-Updated*. Business and Biodiversity Offsets Programme, Washington, DC.

BBOP (2012b) *Resource Paper: Limits to What Can Be Offset*. Business and Biodiversity Offsets Programme, Washington, DC.

BBOP (2012c) *Resource Paper: No Net Loss and Loss-Gain Calculations in Biodiversity Offsets*. Business and Biodiversity Offsets Programme (BBOP), Washington, DC.

BBOP (2012d) *Standard on Biodiversity Offsets*. Business and Biodiversity Offsets Programme (BBOP), Washington, DC.

BBOP (2014) *Biodiversity Offset Design Handbook: Appendices*. Business and Biodiversity Offsets Programme, Washington, DC.

Becca, M., Carroll, D., Kandy, D., and Bennett, G. (2011). Update, State of Biodiversity Markets. Forest Trends. Retrieved from: http://www.forest-trends.org/documents/iles/doc_2848.pdf, 5-6.

Briggs, B.D.J., Hill, D.A., and Gillespie, R. (2009) Habitat Banking - How it Could Work in the UK. *Journal of Nature Conservation,* 17 (2), 112-122.

Bull, J.W., Suttle, B., Gordon, A., Singh, N.J., and Milner-Gulland, E.J. (2013) Biodiversity Offsets in Theory and Practice. *Oryx,* 47 (3), 369-380.

Bull, J.W., Lloyd, S.P. and Strange, N. (2017) Implementation Gap Between the Theory and Practice of Biodiversity Offset Multipliers. *Conservation Letters*, 10(6), 656-669.

Bull, J.W., Baker, J. Griffiths, V.F. Jones, J.P.G. and Milner-Gulland, E.J. (2018). *Ensuring no net loss for people and biodiversity: Good practice principles*. Oxford. https://doi.org/10.31235/osf.io/4ygh7.

Burgin, S. (2010) 'Mitigation Banks' for Wetland Conservation: a Major Success or an Unmitigated Disaster? *Wetlands Ecology and Management,* 18(1), 49-55.

Burkhard, B., Kandzior, M., Hou, Y. and Müller, F. (2014) Ecosystem service potentials, flows and demand: Concepts for spatial localisation, indication and quantification. *Landscape Online,* 34: 1–32.

Business and Biodiversity Offsets Programme (BBOP) (2009) Biodiversity Offsets and Stakeholder Participation: A BBOP Resource Paper. Business and Biodiversity Offsets Programme, Washington, DC.

Calvet, C., Le Coent, P., Napoleone, C., and Quétier, F. (2019). Challenges of achieving biodiversity offset outcomes through agri-environmental schemes: Evidence from an empirical study in Southern France. *Ecological economics*, *163*, 113-125.

Carroll, N., Fox, J., and Bayon, R. (2008) *Conservation and Biodiversity Banking: A Guide to Setting Up and Running Biodiversity Credit Trading Systems*. Earthscan, London.

Clevenger, A.P., and Wierzchowski, J. (2006) Maintaining and Restoring Connectivity in Landscapes Fragmented by Roads. In Crooks, K.R., and Sanjayan, M. (eds), *Connectivity Conservation*, pp 502-535. Cambridge University Press, Cambridge, UK.

Conway, M., Rayment, M., White, A., and Berman, S. (2013) *Exploring Potential Demand for and Supply of Habitat Banking in the EU and Appropriate Design Elements for a Habitat Banking Scheme*. Final Report submitted to DG Environment, ICF GHK, London.

COWI (2009) *Study Concerning the Report on the Application and Effectiveness of the SEA Directive (2001/42/EEC)*. Final Report for European Commission, DG ENV, COWI A/S, Denmark.

Crowder, L., Norse, E. (2008). Essential Ecological Insights for Marine Ecosystem-based Management and Marine Spatial Planning. *Marine Policy*, 32(5), 772–778.

Darbi, M., Ohlenburg, H., Herberg, A., Wende, W., Skambracks, D., and Herbert, M. (2009) *International Approaches to Compensation for Impacts on Biological Diversity*. Leibniz

Institute of Ecological and Regional Development and Berlin University of Technology, Germany.

Darbi, M., Ohlenburg, H., Herberg, A., and Wende, W. (2010) *Impact Mitigation and Biodiversity Offsets - Compensation Approaches from Around the World*. Naturschutz und Biologische Vielfalt 101, Bundesamt für Naturschutz, Bonn - Bad Godesberg.

Darbi, M. (2020). *Biodiversity Offsets Between Regulation and Voluntary Commitment. A Typology of Approaches Towards Environmental Compensation and No Net Loss of Biodiversity*. Springer Nature Switzerland.

EEA (2010) *Assessing Biodiversity in Europe - the 2010 Report*. EEA Technical Report No 5/2010, European Environment Agency, Copenhagen.

EEA (2015) *State of Nature in the EU: Results from Reporting Under the Nature Directives 2007-2012*. Technical Report No 2/2015, European Environment Agency, Copenhagen.

EEA (2019) *The European environment — state and outlook 2020. Knowledge for transition to a sustainable Europe*. European Environment Agency, Copenhagen.

EFTEC and IEEP (2010) *The Use of Market-based Instruments for Biodiversity Protection - the Case of Habitat Banking*. Technical report for European Commission DG Environment, Eftec and IEEP, London.

European Commission (2010a) *Non-energy Mineral Extraction and Natura 2000*. Natura 2000 Guidance Document: EC Guidance on non-energy extractive activities in accordance with Natura 2000 requirements, Publications Office of the European Union, Luxembourg.

European Commission (2010b) *Wind Energy Developments and Natura 2000*. Natura 2000 Guidance Document, Publications Office of the European Union, Luxembourg.

European Commission (2012) Blue Growth – Opportunities for Marine and Maritime Sustainable Growth. Publications Office of the European Union, Luxembourg.

European Commission (2013) *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. European Commission, Brussels.

European Commission (2015) *Natura 2000 and Forests*. Publications Office of the European Union, Luxembourg.

European Commission (2016) *Mapping and Assessment of Ecosystems and their Services - Urban ecosystems. MAES 4th Report.* Technical Report - 2016-102, Publications Office of the European Union, Luxembourg.

European Commission (2019a) *EU guidance on integrating ecosystems and their services into decision-makin*g. SWD (2019) 305.

European Commission (2019b) *Guidance on a strategic framework for further supporting the deployment of EU-level green and blue infrastructure.* SWD(2019) 193.

European Commission (2109c) *Evaluation of the Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment*. SWD(2019) 414 final.

Fox, J., Gardner, R.C. and Maki, T. (2011) Stacking opportunities and risks in environmental credit markets. Environmental Law Reporter 41: 10121–10125.

Gardner, T., and von Hase, A. (2012) *Key Ingredients for Biodiversity Offsets to Achieve No Net Loss*. Unpublished report to the New Zealand Department of Conservation.

Gardner, T.A., Von Hase, A., Brownlie, S., Ekstrom, J.M.M., Pilgrim, J.D., Savy, C.E., Stephens, R.T.T., Treweek, J.R., Ussher, G.T., Ward, G., and ten Kate, K. (2013) Biodiversity Offsets and the Challenge of Achieving No Net Loss. *Conservation Biology,* 27(6), 1254-1264.

Gaucherand, S., Pioch, S., Quétier, F., Barillier, A., and Olivereau, F. (2020) Enjeux des approches territorialisées de la séquence ERC: dialogue autour de quelques questions clé. *Sciences, Eaux and Territoires*, 31, 56-63.

Geneletti, D. (2012) Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 7: 143-149.

Gibbons, P., and Lindenmayer, D.B. (2007) Offsets for Land Clearing: No Net Loss or the Tail Wagging the Dog? *Ecological Management and Restoration,* 8(1), 26-31.

Gilliland, P., and Laffoley, D. (2008) Key Elements and Steps in the Process of Developing Ecosystem-based Marine Spatial Planning. *Marine Policy,* 32(5), 9.

Gonzalez, A., Hochstrasser, T., Fry, J., Scott, P., Carvill, P., Jones, M., and Grist, B. (2012) *Integrated Biodiversity Impact Assessment, Streamlining AA, SEA and EIA Processes: Best Practice Guidance*. Environmental Protection Agency, Ireland.

Gordon, A., Bull, J.W., Wilcox, C., and Maron, M. (2015) Perverse Incentives Risk Undermining Biodiversity Offset Policies. *Journal of Applied Ecology,* 52(2), 532-537.

Griffiths, V.F., Bull, J.W., Baker, J., and Milner-Gulland, E.J. (2019) No Net Loss for People and Biodiversity. *Conservation Biology,* 33(1), 76-87.

Grimm, M., and Köppel, J. (2019) Biodiversity Offset Program Design and Implementation. *Sustainability*, 11, 6903, 1-15.

Grimm, M., Köppel, J., and Geißler, G. (2019) A Shift Towards Landscape-Scale Approaches in Compensation – Suitable Mechanisms and Open Questions. *Impact Assessment and Project Appraisal,* 37(6), 491-502.

Gullison, R.E., Hardner, J., Anstee, S., and Meyer, M. (2015) *Good Practices for the Collection of Biodiversity Baseline Data*. The Multilateral Financing Institutions Biodiversity Working Group and Cross-Sector Biodiversity Initiative, USA.

Haaren, C. von, Lovett, A.A., and Albert, C. (eds) (2019) *Landscape Planning with Ecosystem Services – Theories and Methods for Application in Europe*. Springer Nature Cham.

Hannis, M., and Sullivan, S. (2012) *Offsetting Nature? Habitat Banking and Biodiversity Offsets in the English Land Use Planning System*. Green House, Weymouth.

Hansjürgens, B., Schröter-Schlaack, C., Tucker, G.M. and Vakrou, A. (2010) Addressing the Losses Through Regulation and Pricing. In Brink, P.T. (ed.), *The Economics of Ecosystems and Biodiversity in National and International Policy Making*, pp. 299-343. An output of TEEB: The Economics of Ecosystems and Biodiversity. Earthscan, London and Washington.

Hardner, J. J., Gullison, R. E. and Lowry II, P. P. (2015) Offsets: conservation served by flexibility. *Nature*, *524*(7566), 415-415.

Hersperger, A., Bürgi, M., Wende, W., Bacau, S. and Gradinaru, S.-R. (2020) Does Landscape Play a Role in Strategic Spatial Planning of European Urban Regions? *Landscape and Urban Planning*, 194, 103702, 1-12.

Hossler, K., Bouchard, V., Fennessy, M.S., Frey, S.D., Anemaet, E., and Herbert, E. (2011) No-net-loss not Met for Nutrient Function in Freshwater Marshes: Recommendations for Wetland Mitigation Policies. *Ecosphere* 2 (7), article 82. http://dx.doi.org/10.1890/ES1811-00009.00001.

ICMM (2006) *Good Practice Guidance for Mining and Biodiversity*. ICMM International Council on Mining and Metals.

IEEP, GHK and TEPR (2012) *Background Study Towards Biodiversity Proofing of the EU Budget*. Report to the European Commission, Institute for European Environmental Policy, London.

IPBES (2018) Regional and subregional assessments of biodiversity and ecosystem services: regional and subregional assessment for Europe and Central Asia. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. **IPBES**/6/INF/6/Rev.1.

IUCN (2014). *Biodiversity Offsets Technical Study Paper*. Gland, Switzerland: IUCN.

Iuell, B., Bekker, G.J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlaváx, V., Keller, V., Rosell, C., Sangwine, T., Tørsløv, N., Wandall, B., and le Maire, B. (2003) *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions*. European Co-operation in the Field of Scientific and Technical Research.

Jacob, C., Vaissiere, A-C., Bas, A., and Calvet, C. (2016) Investigating the Inclusion of Ecosystem Services in Biodiversity Offsetting. *Ecosystem Services,* 21, 92-102.

Jacob, C., van Bochove, J. W., Livingstone, S., White, T., Pilgrim, J. and Bennun, L. (2020) Marine biodiversity offsets: Pragmatic approaches toward better conservation outcomes. *Conservation Letters*, e12711.

Koh, N.S., Hahn, T., and Ituarte-Lima, C. (2017) Safeguards for Enhancing Ecological Compensation in Sweden. *Land Use Policy* 64, 186-199

Landsberg, F., Stickler, M., Henninger, N., Treweek, J., and Venn, O. (2014) *Weaving Ecosystem Services into Impact Assessment*. World Resource Institute.

Levrel, H., Scemama, P. and Vaissière, A. C. (2017) Should we be wary of mitigation banking? Evidence regarding the risks associated with this wetland offset arrangement in Florida. *Ecological Economics*, *135*, 136-149.

Lindenmayer, D. B., Crane, M., Evans, M. C., Maron, M., Gibbons, P., Bekessy, S., & Blanchard, W. (2017) The anatomy of a failed offset. *Biological Conservation* 210: 286-292.

Luck G.W., Chan K.M. and Klien C.J. (2012) Identifying spatial priorities for protecting ecosystem services. F1000 Research 2012, 1:17

Mack, J.J., and Micacchion, M. (2006) An Ecological Assessment of Ohio Mitigation Banks: *Vegetation, Amphibians, Hydrology, and Soils*. Ohio EPA Technical Report WET/2006-1, Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, USA.

MAES (2015) *Mapping and Assessment of Forest Ecosystems and their Services: Applications and Guidance for Decision-making in the Framework of MAES*. JRC Science for Policy Report EUR 27751 EN, European Commission, https://doi.org/10.2788/720519.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, B., Puydarrieux, P., Fiorina, C., Santos-Martin, F., Paracchini, M.L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P.H., Condé, S., Schägner, J.P., San Miguel, J., Estreguil, C., Ostermann, O.P., Barredo, J.I., Pereira, H.M., Stott, A., Laporte, V., Meiner, A., Olah, B., Gelabert, E.R., Spyropoulou, R., Petersen, J-E., Maguire, C., Zal, N., Achilleos, E., Rubin, A., Ledoux, L., Murphy, P., Fritz, M., Brown, C., Raes, C., Jacobs, S., Raquez, P., Vandewalle, M., Connor, D., and Bidoglio, G. (2013) *Mapping and Assessment of Ecosystems and their Services: An Analytical Framework for Ecosystem Assessments under Action 5 of the EU Biodiversity Strategy to 2020*. Technical Report - 2013 -067, Publications Office of the European Union, Luxembourg.

Maestre-Andrés, S., Corbera, E., Robertson, M. and Lave, R. (2020). Habitat banking at a standstill: The case of Spain. *Environmental Science & Policy*, *109*, 54-63.

Mandle, L., Douglass, J., Lozano, J.S., Sharp, R.P., Vogl, A.L., Denu, D., Walschburger, T. and Tallis, H. (2016) OPAL: An open-source software tool for integrating biodiversity and ecosystem services into impact assessment and mitigation decisions. *Environmental Modelling & Software*, 84, 121-133.

Maron, M., and Louis, W.R. (2018) Does it Matter Why we do Restoration? Volunteers, Offset Markets and the Need for Full Disclosure. *Ecological Management and Restoration,* 19, 73-78.

Maron, M., Hobbs, R.J., Moilanen, A., Matthews, J.W., Christie, K., Gardner, T.A., Keith, D.A., Lindenmayer, D.B., and McAlpine, C.A. (2012) Faustian Bargains? Restoration Realities in the Context of Biodiversity Offset Policies. *Biological Conservation,* 155, 141-148.

Maron, M., Gordon, A., Mackey, B.G., Possingham, H.P., and Watson, J.E. (2016) Interactions Between Biodiversity Offsets and Protected Area Commitments: Avoiding Perverse Outcomes. *Conservation Letters,* 9(5), 384-389.

Maron, M., Brownlie, S., Bull, J.W., Evans, M.C., von Hase, A., Quétier, F., ... and Gordon, A. (2018) The Many Meanings of No Net Loss in Environmental Policy. *Nature Sustainability,* 1(1), 19.

Maron, M., Simmonds, J.S., Watson, J.E.M., Sonter, L.J., Bennun, L., Griffiths, V.F., Quétier, F., von Hase, A., Edwards, S., Rainey, H., Bull, J.S., Savy, C.E., Victurine, R., Kiesecker, J., Puydarrieux, P., Stevens, T., Cozannet, N. & Jones, J. P.G (2020) Global no net loss of natural ecosystems. *Nat Ecol Evol* 4, 46–49.

Maseyk, F.J.F., Barea, L.P., Stephens, R.T.T., Possingham, H.P., Dutson, G., and Maron, M. (2016) A Disaggregated Biodiversity Offset Accounting Model to Improve Estimation of Ecological Equivalency and No Net Loss. *Biological Conservation,* 204, 322-332.

Mazza, L., Bennett, G., De Nocker, L., Gantioler, S., Loscarcos, L., Margerison, C., Kaphengst, T., McConville, A.J., Rayment, M., ten Brink, P., Tucker, G.M., and van Diggelen, R. (2012) *Green Infrastructure Implementation and Efficiency*. Final report for the European Commission, DG Environment on Contract ENV.B.2./SER/2010/0059, Institute for European Environmental Policy, Brussels and London.

McCracken, R. (2010) EIA, SEA and AA, Present Position. Where Are We Now? *Journal of Planning and Environmental Law,* 12, 1515-1532.

McGuinn., J., Hernandez, G., Eales, R., Sheate, W., and Baker, J. (2013) *Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment*. Report to the European Commission DG Environment, Brussels.

McKenney, B.A., and Kiesecker, J.M. (2010) Policy Development for Biodiversity Offsets: a Review of Offset Frameworks. *Environmental Management,* 45(1), 165-176.

Medarova-Bergstrom, K., Kettunen, M., Rayment, M., Skinner, I., and Tucker, G.M. (2014) *Common Framework for Biodiversity-Proofing of the EU Budget – General Guidance*. Report to the European Commission, Institute for European Environmental Policy, London.

Milieu and Collingwood Environmental Planning (2019) *Study to support the REFIT evaluation of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive). Final report.*

Milieu-en energierecht, 197-215

Moilanen, A., and Kotiaho, J.S. (2018) Fifteen Operationally Important Decisions in the Planning of Biodiversity Offsets. *Biological Conservation,* 227, 112-120

Moilanen, A., Van Teeffelen, A.J.A., Ben-Haim, Y., and Ferrier, S. (2009) How Much Compensation is Enough? A Framework for Incorporating Uncertainty and Time Discounting When Calculating Offset Ratios for Impacted Habitat. *Restoration Ecology,* 17(4), 470-478.

Morandeau, D., and Vilaysack, D. (2012) *Compensating for Damage to Biodiversity: an International Benchmarking Study*. General Commission for Sustainable Development, Paris.

Morris, R.K.A., Alonso, I., Jefferson, R.G., and Kirby, K.J. (2006) The Creation of Compensatory Habitat: Can it Secure Sustainable Development? *Journal for Nature Conservation,* 14(2), 106-116.

National Oceanic and Atmospheric Administration (2006) Habitat Equivalency Analysis: An Overview. Revised May 23, 2006.

Niner, H.J., Jones, P.J.S., Milligan, B. and Styan, C.A. (2017) A Global Snapshot of Marine Biodiversity Offsetting Policy. *Marine Policy*, 81, 368-374.

NNLWG (2013a) *Development of Operational Principles of Any Proposed EU No Net Loss Initiative*. European Commission/Working Group on No Net Loss of Ecosystems and their Services, Brussels.

NNLWG (2013b) *Scope and Objectives of the No Net Loss Initiative*. European Commission/Working Group on No Net Loss of Ecosystems and their Services, Brussels.

OECD (2008) *Policy Coherence for Development: Lessons Learnt*. OECD Policy Brief OECD, Paris.

OECD (2010) *Strategic Environmental Assessment and Ecosystem Services*. DAC Network on Environment and Development Co-operation (Environet).

OECD (2016) The Ocean Economy in 2030. OECD Publishing, Paris. doi:10.1787/9789264251724-en.

OECD DAC (2008) *Strategic Environmental Assessment and Ecosystem Services*. Advisory Note endorsed by the members of the DAC Network on Environment and Development Co-operation (ENVIRONET) at their 8th Meeting on 30 October 2008.

Partidario, M. & Gomez, R.C., 2013, 'Ecosystem services inclusive strategic environmental assessment', *Environmental Impact Assessment Review*, 40: 36-46.

Pech, M. and Étrillard, C. (2016) Le foncier agricole, variable d'ajustement ou déterminant de la compensation écologique?. *Sciences Eaux Territoires*, (2), 60-63.

Pellegrin, C., Sabatier, R., Napoléone, C. and Dutoit, T. (2018) Une définition opérationnelle de la nature ordinaire adaptée à la compensation écologique. Le cas contrasté des régions Centre, Champagne-Ardenne et Paca. *Natures Sciences Sociétés*, 26, 170-188.

Pilgrim, J. D. and Bennun, L. (2014) Will biodiversity offsets save or sink protected areas?. *Conservation Letters*, *7*(5), 423-424.

Pilgrim, J.D., Brownlie, S., Ekstrom, J.M.M, Gardner, T.A., von Hase, A., ten Kate, K., Savy, C.E., Stephens, R.T.T., Temple, H.J., Treweek, J.R., Ussher, G.T., and Ward, G. (2013) A Process for Assessing Offsetability of Biodiversity Impacts. *Conservation Letters,* 6(5), 376-384.

Quétier, F., and Lavorel, S. (2011) Assessing Ecological Equivalence in Biodiversity Offset Schemes: Key Issues and Solutions. *Biological Conservation,* 144(12), 2991-2999.

Quétier, F., Regnery, B., and Levrel, H. (2014) No Net Loss of Biodiversity or Paper Offsets? A Critical Review of the French No Net Loss Policy. *Environmental Science and Policy,* 38, 120-131.

Quigley, J.T., and Harper, D.J. (2006) Effectiveness of Fish Habitat Compensation in Canada in Achieving No Net Loss. *Environmental Management,* 37(3), 351-366.

Rayment, M., Haines, R., McNeil, D., Conway, M., Tucker, G.M., and Underwood, E. (2014) *Study on Specific Design Elements of Biodiversity Offsets: Biodiversity Metrics and Mechanisms for Securing Long-term Conservation Benefits*. DG Environment ENV.B.2/ETU/2013/0060r Final Report, ICF and Institute for European Environmental Policy, London.

Rio Tinto (2012) Staged Approach to Biodiversity Action Planning – Guidance Note. Rio Tinto, London.

Robertson, M., BenDor, T. K., Lave, R., Riggsbee, A., Ruhl, J. B. and Doyle, M. (2014) Stacking ecosystem services. *Frontiers in Ecology and the Environment*, *12*, 186-193.

Rosenthal, A., Verutes, G., McKenzie, E., Arkema, K.K., Bhagabati, N., Bremer, L.L., Olwero, N. and Vogl, A.L. (2015) Process matters: a framework for conducting decision-relevant assessments of ecosystem services, *International Journal of Biodiversity Science, Ecosystem Services & Management*, 11:3, 190-204.

Royal HaskoningDHV (2012) *Environmental Impact Assessment (EIA) and Appropriate Assessment (AA): Evaluation of Assessment Tools and Methods Lot 1 Legal and procedural aspects of the EU Directives*. Commissioned by the Antwerp Port Authority, TIDE Tidal River Development Project.

Rozas-Vásquez, D., Fürst, C., Geneletti, D. and Almendra, O. (2018) Integration of Ecosystem Services in Strategic Environmental Assessment Across Spatial Planning Scales. *Land Use Policy*, 71, 303-310.

Ruhl, J.B., and Salzman, J. (2006) *The Effects of Wetland Mitigation Banking on People*. National Wetlands Newsletter, 28(2), FSU College of Law, Public Law Research Paper No. 179, USA.

Schoukens, H. (2015) Biodiversity Banking: voorbij de tegenstelling natuur versus economie?

Shumway, N., Watson, J. E., Saunders, M. I., & Maron, M. (2018) The risks and opportunities of translating terrestrial biodiversity offsets to the marine realm. *BioScience*, 68, 125-133.

Simeonova, V., Bouwma, I., Grift, E. van de, Sunyer, C., Manteiga, L., Külvik, M., Suškevičs, M., Dimitrov, S., and Dimitrova, A. (2017) *Natura 2000 and Spatial Planning*. Final Report for the European Commission (DG ENV) (Project 07.0202/2015/716477/ETU/ENV. B.3).

Simmonds, J.S., Sonter, L.J., Watson, J.E., Bennun, L., Costa, H.M., Dutson, G., Edwards, S., Grantham, H., Griffiths, V.F., Jones, J.P.G., Kiesecker, J., Possingham, H.P. Puydarrieux, P., Quétier, F., Rainer,H., Rainey, H. Roe, D., Savy, C.E., Souquet, M., ten Kate, K., Victurine, R., von Hase, A., and Maron, M. (2019) Moving from biodiversity offsets to a target-based approach for ecological compensation. *Conservation Letters* e12695. https://doi.org/10.1111/conl.12695

Sonter, L.J., Gourevitch, J., Koh, I., Nicholson, C.C., Richardson, L.L., Schwartz, A.J., ... and Ricketts, T.H. (2018) Biodiversity Offsets May Miss Opportunities to Mitigate Impacts on Ecosystem Services. *Frontiers in Ecology and the Environment,* 16(3), 143-148.

Sonter, L.J., Gordon, A., Archibald, C. et al (2019) Offsetting impacts of development on biodiversity and ecosystem services. *Ambio* https://doi.org/10.1007/s13280-019-01245-3

Sonter, L.J., Simmonds, J.S., Watson, J.E., Jones, J.P., Kiesecker, J.M., Costa, H. M., ... and Jones, K. (2020) Local conditions and policy design determine whether ecological compensation can achieve No Net Loss goals. *Nature Communications*, *11*, 1-11.

Suding, K.N. (2011) Toward an Era of Restoration in Ecology: Successes, Failures, and Opportunities Ahead. *Annual Review of Ecology, Evolution, and Systematics,* 42(1), 465-487.

Syrbe, R.-U. and Walz, U. (2012) Spatial Indicators for the Assessment of Ecosystem Services: Providing, Benefiting and Connecting Areas and Landscape Metrics. *Ecological Indicators*, 21, 80-88.

Tallis, H., and Polasky, S. (2009) Mapping and valuing ecosystem services as an approach for conservation and natural-resource management. *Annals of the New York Academy of Sciences,* 1162, 265-283.

Tallis, H., Kennedy, C.M., Ruckelshaus, M., Goldstein, J., and Kiesecker, J.M. (2015) Mitigation for One and All: An Integrated Framework for Mitigation of Development Impacts on Biodiversity and Ecosystem Services. *Environmental Impact Assessment Review,* 55, 21-34.

Teeffelen, A.J.A. van (2018) The Netherlands. In Wende, W., Tucker, G.M., Quétier, F., Rayment, M., and Darbi, M. (eds.) *Biodiversity Offsets – European Perspectives on No Net Loss of Biodiversity and Ecosystem Services*, pp.191-209. Springer Cham.

ten Kate, K. (2014) Brief synopsis of lessons learned from international offsetting experience. Annex 10 in Tucker, G. M., Allen, B., Conway, M., Dickie, I., Hart, K., Rayment, M., and Schulp, C. J. E. *Policy Options for an EU No Net Loss Initiative*. Report to the European Commission, Institute for European Environmental Policy, London/Brussels.

Tucker, G.M., Allen, B., Conway, M., Dickie, I., Hart, K., Rayment, M., and Schulp, C.J.E .(2014) *Policy Options for an EU No Net Loss Initiative*. Report to the European Commission, Institute for European Environmental Policy, London/Brussels.

Tucker, G.M., Dickie, I., McNeil, D., Rayment, M., ten Brink, P., and Underwood, E. (2016) *Supporting the Elaboration of the Impact Assessment for a Future EU Initiative on No Net Loss of Biodiversity and Ecosystem Services*. Report to the European Commission, Institute for European Environmental Policy, London.

Tulloch, A.I., Gordon, A., Runge, C.A., and Rhodes, J.R. (2019) Integrating Spatially Realistic Infrastructure Impacts into Conservation Planning to Inform Strategic Environmental Assessment. *Conservation Letters*, e12648.

UNEP-WCMC (2016) Marine No Net Loss: A Feasibility Assessment of Implementing No Net Loss of Biodiversity in the Sea. UNEP-WCMC, Cambridge.

Vaissière, A.C., Quétier, F., Bas, A., Calvet, C., Gaucherand, S., Hay, J., Jacob, C., Kermagoret, C., Levrel, H., Malapert, A., Pioch, S., and Scemama, P. (2018) France. In Wende, W., Tucker, G.M., Quétier, F., Rayment, M., and Darbi, M. (eds.) *Biodiversity Offsets – European Perspectives on No Net Loss of Biodiversity and Ecosystem Services*, pp.99-121. Springer Cham.

Vaissière, A. C., Quétier, F., Calvet, C., Levrel, H., & Wunder, S. (2020). Biodiversity offsets and payments for environmental services: Clarifying the family ties. Ecological Economics, 169, 106428.

Van Der Ree, R., Smith, D. J. and Grilo, C. (2015) *Handbook of road ecology*. John Wiley & Sons.

van Teeffelen, A. J., Opdam, P., Wätzold, F., Hartig, F., Johst, K., Drechsler, M., ... & Quétier, F. (2014). Ecological and economic conditions and associated institutional challenges for conservation banking in dynamic landscapes. *Landscape and Urban Planning*, *130*, 64-72.

Von Hase, A., and Cassin, J. (2018) *Theory and Practice of 'Stacking' and 'Bundling' Ecosystem Goods and Services*. BBOP resource paper.

Walker, S., Brower, A.L., Stephens, R.T.T., and Lee, W.G. (2009) Why Bartering Biodiversity Fails. *Conservation Letters,* 2(4), 149-157.

Weissgerber, M., Roturier, S., Julliard, R., and Guillet, F. (2019) Biodiversity Offsetting: Certainty of the Net Loss but Uncertainty of the Net Gain. *Biological Conservation*, 237, 200-208.

Wende, W. (2019) Ecosystem Services and Landscape Planning – How to Integrate Two Different Worlds in a High-Density Urban Setting. In Rinaldi, B.M., and Tan, P.Y. (eds.) *Urban Landscapes in High-Density Cities*, pp.154-164. Birkäuser De Gruyter Basel.

Wende, W., and Darbi, M. (2018) Urban Ecosystem Services and Biodiversity Offsets. In Müller, B., and Shimizu, H. (eds.) *Towards the Implementation of the New Urban Agenda,* pp. 39-47. Springer Cham.

Wende, W., Herberg, A., and Herzberg, A. (2005) Mitigation Banking and Compensation Pools: Improving the Effectiveness of Impact Mitigation Regulation in Project Planning Procedures. *Impact Assessment and Project Appraisal,* 23 (2), 110-111.

Wende, W., Tucker, G.M., Quétier, F., Rayment, M., and Darbi, M. (eds) (2018) *Biodiversity Offsets - European Perspectives on No Net Loss of Biodiversity and Ecosystem Services.* Springer, Cham.

zu Ermgassen, S.O., Baker, J., Griffiths, R.A., Strange, N., Struebig, M.J., and Bull, J.W. (2019) The Ecological Outcomes of Biodiversity Offsets under 'No Net Loss' Policies: A Global Review. *Conservation Letters*, e12664.

ANNEX 1: Glossary of key terms

For consistency, the key terms and their definitions used in this guidance mostly follow those used by the NNL Working Group. These are provided below, together with some other terms of relevance to this guidance. However, it should be noted that these terms were not formally adopted by the NNL Working Group.

Source: NNLWG glossary unless otherwise indicated

Additionality: the need for a compensation measure **to provide a new contribution to conservation, additional to any existing values**; that is, the conservation outcomes it delivers would not have occurred without it (McKenney and Kiesecker, 2010).

Averted risk: The removal of a threat to biodiversity for which there is reasonable and credible evidence. 'Averted risk offsets' are biodiversity offset interventions which prevent future risks of harm to biodiversity from occurring (Conway *et al.*, 2013).

Avoidance: Measures taken to prevent impacts from occurring in the first place, for instance by changing or adjusting the development project's location and/or the scope, nature and timing of its activities (Conway *et al.*, 2013).

Baseline: A description of existing conditions to provide a starting point (e.g. pre-project condition of biodiversity) against which comparisons can be made (e.g. post-impact condition of biodiversity), allowing the change to be quantified. In ecological terms, baseline conditions are those which would pertain in the absence of the proposed development. Baseline studies may be undertaken to determine and describe the conditions against which any future changes can be measured (Conway *et al.*, 2013).

Bio-banking: The name of the offset credits markets in New South Wales, Australia, but the term can be confused with biological banks (e.g. of seeds). To avoid confusion, this term is not used as a synonym of habitat or conservation banking.

Biodiversity Offset Management Plan: A form of management plan (often called a Biodiversity Action Plan) typically adopted by developers to address the mitigation measures set out in the impact assessment which is developed as part of the environmental management plan to ensure their implementation. Biodiversity may be integrated throughout the environmental management plan, or may form a discrete component. Such documents may also incorporate biodiversity offsets, but are generally more focused on project sites (and managing impacts on-site) rather than on offset areas and activities. The BBOP Standard requires a Biodiversity Offset Management Plan to capture the offset's management objectives and general design.

Biodiversity: The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species (genetic diversity), between species, and of ecosystems (CBD).

Biodiversity proofing: A structured process of ensuring the effective application of tools to avoid or at least minimise harmful impacts of EU spending and to maximise the biodiversity benefits. It is applicable to all spending streams under the EU budget, across the whole budgetary cycle and at all levels of governance, and contributes to a significant improvement in the state of biodiversity according to the 2010 baseline and agreed biodiversity targets (IEEP, GHK and TEPR, 2012; Medarova-Bergstrom *et al.*, 2014).

Compensation: Generally, compensation is a recompense for some loss or service, and is something which constitutes an equivalent to make good the lack or variation of something else. It can involve something (such as money) given or received as payment or reparation (as for a service or loss or injury). Specifically, in terms of biodiversity, compensation involves measures to recompense, make good or pay damages for loss of biodiversity caused by a project. However, it should be noted that **compensatory measures**, as referred to in Article 6(4) of the Habitats Directive are analogous to offsets.

Credit: A biodiversity credit is a unit of gain that can be traded in an offset market. Government typically defines a number of different credit types, which may be described as habitat types or in metrics related to particular species, and projects' impacts are converted into a requirement for a certain number of different credit types on the basis of 'like-for-like or better' (Conway *et al.*, 2013).
Cumulative impact: The total impact arising from the project (under the control of the developer); other activities (that may be under the control of others, including other developers, local communities, government) and other background pressures and trends which may be unregulated. (Conway *et al.*, 2013).
Easement: A right to use a part of land which is owned by another person or organisation (e.g. for access to another property). A conservation easement can be defined as a legally binding agreement not to develop part of a property, but to leave it 'natural' permanently or for some designated and very long period of time. The property still belongs to the landowner, but restrictions are placed both on the current landowner and on subsequent landowners. In some countries, 'servitudes' or 'covenants' are legal instruments that can be used to introduce conditions for land use attached to land title that pass from one landowner to the next successor in title (Conway *et al.*, 2013).
Ecological equivalence (see also: 'like-for-like', 'like-for-like or better' and 'trading up'): In the context of biodiversity offsets, the term is synonymous with the concept of 'like-for-like' and refers to areas with highly comparable biodiversity components. This similarity can be observed in terms of species diversity, functional diversity and composition, ecological integrity or condition, landscape context (e.g. connectivity, landscape position, adjacent land uses or condition, patch size, etc.), and ecosystem services (including people's use and cultural values) (Conway *et al.*, 2013).
Equivalence: An offset project is considered equivalent if it is designed and sized in order to achieve ecological gains which are at least equal to the loss at the impacted site.
Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Millennium Ecosystem Assessment, 2005).
Ex-ante (or prospective): 'Before the event': potential, likely or expected. In the context of biodiversity offsets, a 'prospective offset' is one where the decision to undertake an offset is made, and the conditions in the project area are characterised and documented, prior to any impacts associated with the development project.
Ex-post (or retrospective): 'After the event': looking back on or dealing with past events or situations. In the context of biodiversity offsets, a retrospective offset concerns a situation where the impacts associated with the development project have already occurred prior to the decision to undertake a biodiversity offset, or prior to the characterisation of pre-project conditions. Retrospective offsets increase the uncertainty and risk associated with offsets, but can be undertaken successfully if specific conditions are met.
Favourable conservation status: This refers to habitats having sufficient area and quality and species having a sufficient population size to ensure their survival into the medium to long term, along with favourable future prospects in the face of pressures and threats.
Habitat (or conservation) banking: Habitat banking can be defined as 'a market where the credits from actions with beneficial biodiversity outcomes can be purchased to offset the debit from environmental damage. Credits can be produced in advance of, and without ex-ante links to, the debits they compensate for, and stored over time'. Biodiversity credits in the context of this project include both habitats and species (EFTEC and IEEP, 2010).
Habitat: 'Habitat' is strictly a species-concept, referring to the particular abiotic and biotic conditions with which individuals or populations of the same species are typically associated. The term 'habitat' is also often extended to refer to the circumstances in which populations of many species tend to co-occur, in which case it is strictly a biotope.
Habitat hectares: Units of measurement that take into account the area affected and the quality or condition of the biodiversity impacted (determined by the quantities of a number of chosen attributes related to the structure, composition and function of that habitat) (Conway *et al.*, 2013).

Like-for-like: Conservation (through the biodiversity offset) of the same type of biodiversity as that affected by the project. Sometimes referred to as in-kind. If an offset conserves components of biodiversity that are a higher conservation priority than those affected by the development project for which the offset is envisaged. This is also known as '**like-for-like or better'** or '**trading up**' (Conway *et al.*, 2013).

Mitigation: Measures which aim to reduce impacts to the point where they have no adverse effects (Conway *et al.*, 2013).

Mitigation banking. Mitigation banking in the USA is akin to offsetting, but the term 'mitigation banking' is inconsistent with the use of the term 'mitigation' outside the USA. Therefore, the term is not used as a synonym of habitat or conservation banking.

Mitigation hierarchy: A hierarchical procedure where appropriate actions are taken in the following order: avoidance, reduction/minimisation, restoration/rehabilitation and offsetting (see NNLWG glossary for detailed discussion).

No net loss (NNL): In which the impacts on biodiversity caused by a project (or plan or programme ([58])) are balanced or outweighed by measures taken to avoid and minimise the project's (plan's or programme's) impacts, to undertake on-site restoration and finally to offset the residual impacts, so that no loss remains. Where the gain exceeds the loss, the term 'net gain' may be used instead. No net loss (or net gain) of biodiversity is a policy goal in several countries, and is also the goal of voluntary biodiversity offsets. (Conway *et al.*, 2013)

Net gain (NG): See **no net loss**: where the gain exceeds the loss, the term 'net gain' may be used instead.

Offset: Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. **The goal of biodiversity offsets is to achieve no net loss and preferably a net gain** of biodiversity on the ground with respect to species composition, habitat structure and ecosystem function and people's use and cultural values associated with biodiversity (BBOP definition).

Out-of-kind: When the biodiversity conserved through the offset differs in kind from the biodiversity impacted by the project. The option of 'trading up' to an out-of-kind offset may be advisable where an offset arising from project impacts on a common or widespread component of biodiversity may instead be switched to benefit a more threatened or rare component (Conway *et al.*, 2013).

Ratio: Two types of ratios can be distinguished:

- Ratios resulting from an analysis of qualified areas on the project site and on the offset site (comparison ratio, evaluated ratio); and
- Ratios not resulting from an analysis of qualified areas on the project site and on the offset site, either to fully design the offset (practice to be avoided) or to take risks into account in the last step of the offset design (risk multipliers).

Rehabilitation: Rehabilitation shares with restoration a fundamental focus on historical or pre-existing ecosystems as models or references, but the two activities differ in their goals and strategies. Rehabilitation emphasises the reparation of ecosystem processes, productivity and services, whereas the goals of restoration also include the re-establishment of pre-existing biotic integrity in terms of species composition and community structure. Reclamation projects that are more ecologically based can qualify as rehabilitation or even restoration (Conway *et al.*, 2013).

Restoration: The process of assisting the recovery of an area or ecosystem that has been degraded, damaged, or destroyed. The aim of ecological restoration is to re-establish the ecosystem's composition, structure and function, usually bringing it back to its original (pre-disturbance) state or to a healthy state close to the original. An ecosystem is restored when it contains sufficient biotic and abiotic resources to sustain itself structurally and functionally and can continue its development

[58] This NNL Working Group definition is revised because, while the term NNL in general usage focuses on projects, it also applies to plans or programmes (e.g. a regional programme under the Cohesion Policy, see Hjerp *et al.*, 2013). It could also be used in a wider sense as, for example, for policies, though this is part of wider biodiversity proofing.

without further assistance or subsidy. Restoration is frequently confused with rehabilitation; while restoration aims to return an ecosystem to a former natural condition, rehabilitation implies putting the landscape to a new or altered use to serve a particular human purpose (Society for Ecological Restoration).

ANNEX 2. POTENTIAL ADVERSE IMPACTS ON BIODIVERSITY FROM BUILT DEVELOPMENTS, AND POSSIBLE INTERVENTION MEASURES TO AVOID, REDUCE AND COMPENSATE FOR IMPACTS

Source: Biodiversity Background Proofing Study (IEEP, GHK and TEPR, 2012).

Impact source / impact type	Direct mortality	Direct habitat loss (footprints)	Habitat fragmentation	Disturbance	Indirect habitat degradation	Secondary impacts
Buildings and associated lighting*[1]	Tall glass and illuminated buildings can be significant hazards for birds	Variable	Can form barriers to movement for some sensitive species, causing fragmentation	Disturbance from people nearby, and some species avoid buildings, and lighting can affect nocturnal species	Normally minimal	The presence of buildings may encourage further development
Heavy industry, chemical plants, incinerators and power stations	Toxic pollutants can cause significant impacts	Generally relatively moderate	Can form barriers to movement for some sensitive species, causing fragmentation	As for buildings	Ecosystem disruption from pollutants can reduce food resources	The presence of industry etc. may encourage further development
Transport: roads, railways, ports, airports	Some collisions may occur, especially where roads cross flight-lines animal crossing points, but impacts relatively low	Relatively low, but can be concentrated along biodiverse coastal strips (causing coastal squeeze), lakes and river valleys	Can be significant, e.g. where new infrastructure occurs in unfragmented landscapes, and where disturbance-sensitive species occur that require large areas of habitat	Often substantial disturbance impacts, but some species become habituated especially if people are not visible	Hydrological disruption, polluted run-off and air-pollutants (especially NOx) can disrupt ecosystems and food resources	Increased hunting pressures and recreational disturbance if access is improved. Encourages further development
Water treatment plants and drains	Significant detrimental impacts are unlikely	Normally small	Significant detrimental impacts are unlikely	Normally small	Pollution of water courses and coastal areas, near to outfalls, but higher levels of treatment reduce overall ecosystem impacts	Unlikely
Flood defences and land reclamation	Some impacts in flood storage areas	Can lead to significant loss of upper tidal habitat (coastal squeeze)	May fragment floodplain/coastal habitats	Disturbance during construction and maintenance works	Can have large-scale impacts on coastal geomorphology and adjacent habitat and profound hydrological impacts on adjacent floodplains	Encourages development of flood-protected areas
Dams for hydro-power or water storage	Losses of some species, e.g. ground-nesting birds from flooding	Increases open water but at the expense of other habitats (e.g. mires).	Causes significant fragmentation of river ecosystem and associated habitats	Disturbance during construction and maintenance works	Disruption of down-stream flow regime (e.g. causing low summer flows and reduced flooding of adjacent wetlands)	Reservoirs are frequently subject to significant tourism and recreational impacts

Impact source / impact type	Direct mortality	Direct habitat loss (footprints)	Habitat fragmentation	Disturbance	Indirect habitat degradation	Secondary impacts
Overhead electricity transmission lines	Collisions occur, especially where lines cross flight-lines and sites with large numbers of birds; population impacts normally low for most species, but potentially high for some vulnerable species	Generally insignificant	Generally insignificant effects, but lines can form barriers to movement for some vulnerable species, causing habitat fragmentation	Potential disturbance during construction	Normally no significant impact likely	Normally no significant impact likely
Underground electricity transmission lines, gas, oil and carbon-dioxide pipelines and storage	Normally no significant impact likely	Impacts are normally low and reversible, but can lead to habitat loss of some sensitive habitats that cannot be restored; this can be significant if they are rare	Normally no significant impact likely	Potential disturbance during construction	Excavation can lead to pollution of water courses from run-off	Normally no significant impact likely
Wind turbines	Bird and bat collisions can be significant where turbines are inappropriately placed	Normally insignificant from turbines, but service roads can be significant	Can form barriers to movement for some sensitive species, causing fragmentation	Some species avoid turbines. Some disturbance during maintenance	Can cause some hydrological disruption, e.g. as a result of service roads	Increased hunting pressures and recreational disturbance if service roads improve access
Intervention measures to address potential impacts						
Avoidance measures	Avoid areas with sensitive species or known movement corridors	Avoid areas with sensitive species or threatened habitats	Avoid areas with sensitive species or where habitat patches may become too small to support viable populations and ecosystem functions	Avoid areas with sensitive species	Avoid activities that lead to pollution levels that cannot be reduced to acceptable levels	Avoid sensitive areas and/or include regulations to avoid secondary development
Reduction measures	Mark structures to reduce collisions, fence off roads, remove tall vegetation close to roads/railways, etc.	Minimise footprint, e.g. for roads by reduction of carriageways and associated infrastructure, use of viaducts or tunnels to avoid especially sensitive areas	Maintain some habitat linkages, or if not possible then use wildlife tunnels and green bridges etc – at known key crossing points where ecological benefits are reliable and cost-effective	Sound and light barriers (e.g. fences, trees) use of low-noise technologies, limited use of lighting or screened lighting	Technologies to reduce or capture emissions, barriers to pollution (e.g. trees), pollution traps. Monitoring and, if necessary, actions to address alien species risks	Limiting access points from roads to adjacent habitats, especially in sensitive areas, e.g. by absence of joining secondary roads
Compensation measures	Reduction of other sources of mortality, e.g. from alien predators	Habitat restoration or creation, if this is feasible	Strategically placed habitat restoration / creation to link up or increase the area of fragmented habitat patches	Reduction in other sources of disturbance, or habitat restoration or creation, if this is feasible	Habitat restoration or creation, if this is feasible	Habitat restoration or creation, if this is feasible