



Ecological compensation: From general guidance and expertise to specific proposals for road developments



Ana Villarroya ^{a,*}, Jesper Persson ^b, Jordi Puig ^a

^a Department of Zoology and Ecology, University of Navarra, c/Iruñlarrea s/n, 31008 Pamplona, Navarra, Spain

^b Department of Landscape Management, Design and Construction, Swedish University of Agricultural Sciences (SLU), P.O. Box 66, SE-230 53 Alnarp, Sweden

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ABSTRACT

The main scientific bibliography addressing the rationale behind ecological compensation is reviewed in order to examine general guidelines. This contains interesting general guidance on how to implement compensation, and provides the basis for future developments in compensation practice. On this basis, we propose a further step in compensation practice, advancing compensation proposals or rules for specific kinds of projects and contexts, focusing on road projects in the Spanish Environmental Impact Assessment (EIA). Three main residual impacts of roads are identified which usually remain uncompensated for: the loss of natural and semi-natural land use, the increase in emissions resulting from any new road, and the fragmentation, severance or barrier effect on the landscape and its wildlife. To counteract these, four proposals, or “rules”, are advanced: conservation of natural and semi-natural land use area, conservation of dominant plant species physiognomy, compensation for emissions, and the rule of positive defragmentation.

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1. Introduction

Human development often causes negative impacts on natural assets. Changes in land use, such as urbanization or road construction, inevitably cause damage to the natural or ecological aspect of the environment, to a greater or lesser extent (Dale et al., 2000; Forman and Alexander, 1998; Forman et al., 2003; Hansen et al., 2005; Kalnay and Cai, 2003; Vitousek et al., 1997). For some areas it may be said that “we are creating a built infrastructure at the expense of natural infrastructure” (Madsen et al. 2010, p.1).

The existing regulations on nature conservation and Environmental Impact Assessment (EIA), among other regulatory tools, seek to restrict these negative impacts. Moreover, there is a growing sense that promoting positive change is a better way to move towards sustainability than by merely minimizing the negative effects that development may have on the natural environment (Pope et al., 2004). Following this line of thought, it is increasingly argued that development should produce ‘no net losses’ or even achieve ‘net gains’ in the natural quality of the environment, thus counteracting the cumulative impact of development that would otherwise gradually reduce this quality (Hayes and Morrison-Saunders, 2007; van Merwyk and Daddo, undated). Even if these impacts appear insignificant when regarded separately, their

progressive accumulation in the environment leads to greater losses in the long term (Race and Fonseca, 1996).

The so-called ‘mitigation hierarchy’ has been widely recommended as a way to seek no net loss on the natural quality of areas with development projects. It establishes that the optimal sequence to confront environmental impacts should be: (1) avoid, (2) minimize, and (3) compensate the damage that the project is expected to cause (Darbi et al., 2009; Dolan et al., 2006; EU, 2001; USC, 2002).

Compensatory measures are the last sequential step in this mitigation hierarchy. They are thus the last possible chance to achieve the ‘no-net-loss’ or ‘net-gain’ goals (Gibbons and Lindenmayer, 2007; Luell et al., 2003; McKenney, 2005; Moilanen et al., 2009; Rowe et al., 2009; ten Kate et al., 2004). Compensation may either reinstate the natural value that is lost even after avoidance and minimization have been thoroughly implemented (Cuperus et al., 1996; Luell et al., 2003), or improve the original quality of the damaged environment (EPA, 2006; Kuiper, 1997; McKenney, 2005).

Although the *idea* is increasingly accepted, present-day compensation *practice* is still far from reaching these goals. For example, recent studies on EIA Records of Decision (RODs)¹ in Spain showed that compensation was frequently overlooked. Moreover, when actually implemented, compensatory measures were not designed, chosen or selected in a way that was adequately reasoned (Villarroya and Puig,

* Corresponding author. Tel.: +34 948 425600x806281; fax: +34 948 425649.

E-mail addresses: avillarroya@alumni.unav.es (A. Villarroya), jesper.persson@slu.se (J. Persson), jpbaguer@unav.es (J. Puig).

¹ A ROD is the publicly available document where the approving agency presents the main factors that were contemplated to reach the final decision on every project, including the practical means to avoid or minimize environmental harm.

2010). For instance, no attempt was found across the RODs at justifying the degree of equivalence between residual impacts (i.e. those impacts which cannot be avoided nor reversed) and the measures proposed to compensate them.

Although the concept and rationale underlying compensation may be easy to understand, the choice and design of specific offsets to be implemented in each development project are usually a harder task. This constraint is inherent to the nature of compensation, as there is a wide open range of suitable measures for each case. When it comes to specifying compensation measures, two particular issues give rise to problems:

- a. Location. Cuperus et al. (2002) stated that while mitigation measures are physically tied to the infrastructure, compensation may take place anywhere. Whether the reader agrees with this view or not, it is obvious that a suitable place to implement compensatory measures has to be found, which must be adapted to each case.
- b. Equivalence to the damaged feature. The correspondence between the negative effects and the compensatory measures to counterbalance them may be difficult to weigh up (van Bohemen, 1998). The equivalence will depend on several factors (including environmental goals and impact characteristics) which are not always easy to gauge and balance.

The design of compensatory measures seems to demand a case-by-case solution. At the same time, to address compensation practice as consistently as possible, some general accepted guidance and expertise are needed to somehow *justify* to a greater or lesser extent the decisions that are taken along the compensation process (see Kuiper, 1997).

This article focuses on ecological compensation, which can be defined as “the substitution of ecological functions or values that are impaired by development” (Cuperus et al., 2001). It examines published recommendations given to guide its implementation, and the rationale behind them. It aims to collect and discuss the guidance and expertise concerning compensation in order to channel it towards particular compensation processes. Even though our proposals center on specific problems that have been registered for Spain, our approach addresses general issues that may be of application to other contexts.

2. Theory: guidance and expertise on the design of compensatory measures

The design of compensatory measures has to fit the particularities of each case. It is therefore not easy to find valid general guidance, suitable for a wide range of particular cases, on how to select the kind of compensation to be applied. In fact, what Race and Fonseca (1996) observed several years ago remains true today, since it still cannot be said that there is a universally accepted standard regarding this matter.

Several authors have provided guidance on the design, choice or implementation of compensatory measures. They explain the different rationales for choosing one option or another when it comes to location of offsets and equivalence to the damaged features. Some recommend one option over the rest, while others just explain the advantages and/or disadvantages of each choice.

Regarding these issues (location and equivalency), the current literature describes the following options:

- o When it comes to the location of the offsets to be implemented, compensation may be labeled as “in-site” or “off-site”, depending on whether the measures are located within or outside the effect zone of the project (Brinson and Rheinhardt, 1996; Cuperus et al., 1999).
- o Regarding the equivalency of habitats or species, compensation may be either in-kind or out-of-kind, depending on whether it is aimed at the same assets (habitat, species or functions) that were impaired, or at different ones (Brinson and Rheinhardt, 1996; Cuperus et al., 1999).

To put together the advantages and disadvantages that have been identified for each of these options, a bibliographic review was conducted. We looked for publications that addressed environmental compensation, using “environmental compensation”, “ecological compensation”, “compensatory mitigation”, “offsets”, “no net loss” and “net gain” as the main search terms for the title, abstract, keywords or main text in both scientific and general databases. After that initial selection, we established whether the documents included any discussion or recommendations on how to decide the location and kind of offsets. Only those documents that explained the rationale behind their proposals were selected. Other papers not specifying this rationale were set aside. As a consequence, legal texts were not taken into account in this case, since although they sometimes provide some recommendations on offset location and/or equivalence, they do not focus on the rationale behind this guidance. Papers that just cited other authors’ discussion or recommendations on compensation guidance (without adding anything new) were not selected. Fifteen publications were found that met all these requirements, which included explanations of pros/cons and sometimes also recommendations on how to decide the location of offsets and/or their equivalency to the impaired natural features (see list in Table 1).

Thirteen publications addressed how to choose the location of compensatory measures. While seven advise on-site over off-site compensation, two advise the contrary. Among the fifteen documents reviewed, eight were found to address what might be the equivalency for impacted habitats or species. Six of them included some clear recommendation, always prioritizing in-kind over out-of-kind compensation. The implementation of in-kind and on-site offsets, whenever possible, is the most widely mentioned recommendation among the publications reviewed. Nevertheless, no consensus has been reached, and discussion will doubtless continue on this matter.

Arguments for or against alternative compensation options, briefly summarized in Table 2, are reviewed below in more detail. Even though they may seem to be opposed to each other when considered in the abstract, the joint consideration and final choice of which of these arguments should be prioritized in each case may help to strengthen the rationale for compensation proposals in specific cases.

Advantages of in-kind offsets:

- o They have the greatest potential to minimize local disruption of ecological functions, especially when located on-site. This is of great importance in areas where significant ecological linkages and functions have not been completely lost (Race and Fonseca, 1996). This approach may be particularly of use when compensation seeks to prevent certain species, habitats, or ecosystems from being progressively degraded while others receive all the benefits of the compensatory measures (Hayes and Morrison-Saunders, 2007).

Table 1
Selected documents for review.

Year	Resource	References
1996	Scientific papers	Race and Fonseca, 1996; Brinson and Rheinhardt, 1996; Hashisaki, 1996; Mitsch and Wilson, 1996
1998	Scientific paper	van Bohemen, 1998
2001	Book	National Research Council, 2001
2003	Report	Iuell et al., 2003
2004	Report	ten Kate et al., 2004
2004	PhD dissertation	Cuperus, 2004
2005	Report	McKenney, 2005
2006	Scientific paper	Morris et al., 2006
2006	Book chapter	Reijnen and Foppen, 2006
2007	Scientific paper	Hayes and Morrison-Saunders, 2007; Latimer and Hill, 2007
2010	Scientific paper	Kiesecker et al., 2010

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