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Biodiversity offsetting: valuation aspects and development of environmental compensation tools

Direttore della Scuola: Prof. Mario Lenzi

Supervisore: Prof.ssa Paola Gatto

Dottoranda: Ariadna Chavarria Resendez

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"Conservation is a state of harmony between men and land."

-Aldo Leopold

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Abstract

The loss of ecosystem functions and services related to the land-use change has become a concerning issue in Europe. The European Union has committed to reducing the ecosystems loss through the Biodiversity and the No Net Loss (NNL) Strategies (2012). These strategies propose instruments to ensure NNL, and invite the Members States (MS) to implement novel forms to compensate the loss over the environment, as for instance biodiversity offsetting mechanisms (BO) (European Commission 2011, Conway et al., 2013b; Turcker et al., 2014; Froger and Hrabanski, 2015).

There are mature and nascent biodiversity offsetting schemes addressing the loss of ecosystem functions and services due to the adverse environmental effects of developments project. Biodiversity Banking mechanisms are Market-Based Instruments for biodiversity offsetting (MBI) developed to offer a more cost- and ecological-effective solution to compensate the environment through the acquisition of credits delivering ex-ante, and often, in-kind and off-site conservation actions. Biodiversity banks were developed by the first time in the 1970's in USA and their pioneer appearance and implementation for conservation has inspired countries to develop a similar market and non-market based schemes to address ecological compensation of development projects. However, little has been studied from a scientific point of view on how environmental compensation can occur through a market-based mechanism.

The overall aim of this research is to extend the scientific knowledge on the use of Biodiversity Offsetting Schemes as an instrument to regulate and deliver compensation for environmental impacts. More specific, this research provides a scientific background on the ecological impacts assessment methods and the institutions and policies of existing and nascent offsetting mechanism in the USA and Europe. This thesis presents an overview the current European initiatives and Directives, and the Members States regulations on environmental impacts compensation. Also, this thesis analyses the empirical use of the USA Conservation and Conservation Banking to identify the key institutional, political and ecological components needed for the scheme functioning. Lastly, this thesis presents a crossed-analysis between the EU and the USA schemes practices to discuss the theory-practices gap of these schemes. To conclude this thesis analyses the Italian Member State regulations for environmental impacts compensation to finalise with a proposal of actions to develop a market-based mechanism for biodiversity compensation that can be applied in Italy and other European countries.

Riassunto

L'impoverimento degli ecosistemi e del loro funzionamento a causa dell'utilizzo incontrollato dei territori, sta diventando, sempre più, un tema estremamente rilevante in Europa. L'Unione Europea si è impegnata a ridurre tale impoverimento degli ecosistemi attraverso la Strategia per la Biodiversità e la quella del *No Net Loss* (2012). Queste strategie propongono gli strumenti necessari a garantire il mantenimento del funzionamento degli ecosistemi, e invitano gli Stati Membri (SM) ad implementare meccanismi innovativi che possano compensare tali perdite ambientali, quali per esempio il Biodiversity Offsetting (BO) (si veda in merito: European Commission 2011, Conway et al., 2013b; Turcker et al., 2014; Froger and Hrabanski, 2015).

Nel mondo esistono numerosi e crescenti schemi di compensazione sulla biodiversità che trattano il degrado dei servizi ecosistemici, specialmente quelli che si soffermano sugli effetti nocivi per l'ambiente di taluni piani di sviluppo. I meccanismi basati su transazioni di mercato sono stati sviluppati negli USA per offrire una soluzione più efficace in termini ecologici ed economici. Questi meccanismi di mercato funzionano attraverso l'acquisto di crediti di habitat che forniscono azioni di conservazione a titolo preventivo, e spesso, in modalità like-for-like in luoghi diversi al luogo impattato. Le banche biodiversità sono il migliore esempio di meccanismo compensativo di mercato. Queste banche sono state sviluppate negli anni Settanta negli USA, e la loro pionieristica comparsa, unitamente all'obiettivo di salvaguardia dell'ambiente, ha ispirato diversi paesi a sviluppare sistemi simili, basati sia su meccanismi di mercato e non, al fine di compensare dal punto di vista ambientale i progetti di sviluppo. Tuttavia, dal punto di vista scientifico sono ancora trascurabili i contributi riguardanti gli elementi necessari per un sistema di compensazione ambientale basato sui meccanismi di mercato.

L'obiettivo principale di questa tesi è di ampliare la conoscenza scientifica relativa all'uso di meccanismi che si fondano su *Biodiversity Offsetting*, inteso come strumento per regolare e promuovere un riequilibrio degli ecosistemi. In particolar modo, questa ricerca fornisce una rassegna dei metodi di valutazione utilizzati per stimare gli effetti di tali cambiamenti ambientali, del ruolo esercitato dalle istituzioni e le relative politiche adottate per implementare schemi compensativi di tale impoverimento ecologico, sia nel contesto americano sia europeo. Tale studio, poi, analizza empiricamente lo schema

compensativo statunitense adottato in ambito di impatto sugli habitat e specie protette, i.e. lo schema di *Conservation Banking*. Successivamente, questo contributo presenta un'analisi comparativa degli schemi adottati dall'UE e dagli USA per discutere di eventuali disparità che possano emergere, da un punto di vista puramente teorico e concettuale, tra i modelli osservati. Infine, per concludere, vengono esaminate le normative italiane per la compensazione degli impatti ambientali in tema di biodiversità, con l'intento di presentare una proposta operativa volta ad incentivare meccanismi di mercato applicabili sia in Italia sia in altri paesi europei.

Acronyms

BB	Biodiversity Banking
BBOP	Business and Biodiversity Offsets Programme
BEI	Banking Enabling Instrument
BO	Biodiversity Offsetting
CB	Conservation Banking of Enlisted Species (USA)
CEQA	California Environmental Quality Act
CWA	Clean Water Act
CWA	Clean Water Act (short name for the FWPCA)
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
EIA	Environmental Impact Assessment
EIAD	Environmental Impact Assessment Directive
EPA	Environmental Protection Agency
ES	Ecosystem Services
ESA	Endangered Species Act (USA)
FSA	Food Security Act
FWPCA	Federal Water Pollution Control Act
GFNCA	Federal Nature Conservation Act
HD	Habitat Directives
HEA	Habitat Equivalence Analysis
HEP	Habitat Equivalence Procedure
HHA	Habitat Hectares Approach
HU	Habitat Unit
IEEP	Institute for European Environmental Policy
IMR	Impact Mitigation Regulation, *Eingriffsregelung*
IRT	Interagency Review Team (USA)

ISPRA	Italian Institute for Environmental Protection and Research, *Istituto Superiore per la Protezione e la Ricerca Ambientale*
LUC	Land Use Change
MB	Mitigation Banking for Wetlands (USA)
MBI	Market-based instruments
MEEDE	Ministry of the Ecology, the Sustainable Development and the Energy
MRT	Multiagency Review Team (USA)
MS	Members States
N.A.	Not Applicable
NNL	No Net Loss
NOAA	National Oceanic and Atmospheric Administration
NPL	Nature Protection Law (England)
NREA	Natural Resource Equivalency Analysis
NFWF	National Fish and Wildlife Foundation
PES	Payment for Ecosystem Services
REA	Resource Equivalence Analysis
RIBITS	Regulatory In-lieu fee and Bank Information Tracking System
SAC	Special Areas of Conservation
SCI	Sites of Community Interest
SPA	Special Protection Area
SPA	Special Protection Areas
SPV	Superstrada Pedemontana Veneta
SSSI	Site of Special Scientific Interest
USACE	United States Army Corp of Engineers
USBB	United States Biodiversity Banking
USFWS	United States Fish and Wildlife Service
WBD	Wild Birds Directive

Part I

FUNDAMENTS

CHAPTER

ONE

INTRODUCTION

"The beginning of the most important part of the work"

-Plato

1.1 Background

Terrestrial ecosystems provide various functions, goods, and services to support the life on earth. Ecosystem functions refer to the biological and the fundamental process of ecosystems, that support the delivery of food and services for the benefit of humans (Constanza, et al., 1997). The Ecosystem Services (ES) are provided by a variety of natural and semi-natural ecosystems and landscapes that become necessary for human activities as they provide essential services for waste assimilation, water retention and supply, erosion control and sediment retention, air purification, recreation and culture (CIFOR, 2005). Such ES in turn support semi-natural anthropogenic activities like agriculture, hunting and fishing that respond to the society needs for food, housing, jobs creation and health care. Urbanisation and intensive agriculture are common activities that help satisfy society needs often in exchange for land for other ecosystem functions. The change of land use (LUC) alters ecosystem functions, and their provision of goods and services (Haygarth & Ritz, 2009; Ellis et al., 2013) jeopardising the entire ecosystem balance and conservation.

Development activities referred as development projects in this study, are infrastructure improvements carried out to deliver social benefits and contribute to welfare in response to society needs (Constanza, et al., 1997). Development projects benefit society by responding to the needs of energy, transport, health facilities and education. The planning and execution of such projects often follow economic and ecological sustainability principles, as well as, comply with environmental legislations avoiding environmental injuries resulted by the change of land use. Land degradation, habitat conversion, air and water pollution are examples of common environmental consequences of development projects. Regulations governing the execution of development projects aim to guide improvement towards a sustainable and responsible development that protect the ecosystems (TEEB, 2010).

It is important to clarify that the concept of compensation for environmental damage is different from the compensation for impacts occurred during the execution of a development project. The former are losses over the natural resources and services caused by undesired circumstances as an accidental oil spill or hazardous substances, natural disaster occurrence, etc., while the latter refer to the residual unavoidable temporary or permanent losses of the natural resources and services due to the LUC related with a development project. The compensation of environmental damages and environmental impacts can have standard methods used to assess the ES injuries. However, their main differences centres in the predictability of the environmental injuries and the compensation processes regulated because the damage is not predictable and neither it is agreed to happen, while an environmental impact due to development is an authorised action. In Europe, environmental damage compensation is regulated by the Environmental Liability Directive (ELD, 2004/35/EU), and the environmental impacts of development projects are addressed by the Habitats, Wild Birds and the Environmental Impacts Assessment Directives (Chapter 4). In this thesis, the Habitat Equivalence Methods, commonly used in environmental damage, is explored to be used in compensation for LUC-caused impacts (Chapter 5). Nonetheless, this thesis does not address the process and regulations related to environmental damages to a larger extent.

The loss of ecosystem functions and services related with LUC has become a concerning issue in Europe. Consequently, the European Union has committed to reducing the loss of ecosystems through the Biodiversity and the No Net Loss (NNL) Strategies (2012). All Members States (MS) are encouraged to half their biodiversity loss and restore 15% of the European degraded ecosystems by 2020 (target 2 of Biodiversity Strategy; European Commission, 2011). These strategies propose instruments to ensure NNL, and invite the MS to implement novel forms to compensate the loss over the environment, as for instance biodiversity offsetting mechanisms (BO) (European Commission 2011, Conway et al., 2013b; Turcker et al., 2014; Froger and Hrabanski, 2015).

Italy hostess a large number of the European endangered species. The country supports nearly 50% of the plant species and 30% of the animal species of all Europe (ISPRA, 2014). The Italian history of civilisation has developed a unique mosaic of rural landscapes that have evolved since the time of the Roman Empire (Agnoletti, 2012). More recently, in Italy, 55 hectares per day are paved (ISPRA, 2015). In the last thirty years, the LUC in Italy has been driven mainly by urban growth, a surface decrement of farmlands in lowlands and an increment of forest covered areas in the highlands because of lands abandonment (Marchetti et al., 2014). The high urbanisation rate and the low compensation actions of such land use changes are causing the decrement of permeable land important for sustaining the biodiversity, hydric retention and other ecosystem services. Consequently, the ES provision in Italy can be considered in jeopardy (Foley et al. 2005; Newbold et al., 2015).

New conservatory and compensatory actions are needed to tackle the loss of ES and protect the remaining ecosystem functions, goods, and services. The development and implementation of novel environmental regulations inspired by the European NNL and Biodiversity Strategy can play a key role in the integration of environmental conservation, and satisfaction of society needs. Some countries in Europe have already started to develop and implement schemes to compensate environmental impacts derived from development projects. France and Germany, mandatorily, and Spain and the UK, voluntarily, have taken insights from the USA Conservation and Mitigation Schemes to develop and implement new regulations for environmental impacts compensation. These European offsetting schemes are setting the ground for more advanced and consistent policies for the conservation of European threatened and endangered species and habitats (Madsen et al., 2010; Madsen et al., 2011; Conway et al., 2013). In this thesis, the concept of 'environmental impacts compensation schemes/programs/mechanism' will be referred as Biodiversity Offsetting (BO).

On May 28, 2015, the Italian Government approved a decree that will set the basis to develop and enforce new policies for safeguarding the ES provision and move towards the implementation of a NNL initiative. The decree recommends the use of green infrastructure (i.e. including ecological corridors, riparian and coastal green belts, multi-functional farms, wildlife overpass, etc.) in response to the indications from the EU to use more 'cost-effective' alternatives from grey infrastructure (European Commission, 2016). Consecutively, the Italian Parliament has recently amended the environmental section of the Italian of 2014, in particular, the Article 70, which grants the Government complete authority to implement Payment for Ecosystem Services (PES) (Camera dei Deputati, 2016). PES, are market-based instruments (MBI) supporting the provision of ES, and in this regard, PES-like schemes can be implemented to compensate for environmental impacts.

In Italy, there are few local initiatives that, to some extent, can be considered a PES for environmental impacts compensation, i.e. a Biodiversity Offset Scheme (Pileri, 2007). One excellent example is 'The Lombardy's Green Found'. Although these type of schemes are working towards NNL, additional steps need to be undertaken to develop and implement a MBI of Biodiversity Offsetting that would respond to the EU Biodiversity and NNL Strategies, and the recent environmental amendment of the Italian Stability Law of 2014 and the newArticle 70.

1.2 Problem statement

Market-based biodiversity offsetting schemes are widely used in countries like USA and Australia to compensate environmental impacts derived from development projects. The European Union has shown interest in developing novel mechanisms for biodiversity compensation through the "Biodiversity Strategy 2020" and its initiative of "No Net Loss" launched in 2012. These two strategies aim to boost the development and experimentation of new schemes for environmental impacts compensations that would help improve the conservation of ecosystems across Europe. In that sense, the recently amended the Italian Environmental Law of 2014 and its new Article 70 becomes the most important policy granting the Italian Government complete authority to develop and implement a new Biodiversity Offsetting Scheme based on the concept of Payment for Ecosystem Services.

Currently, the enforced policies for environmental impacts compensation in Italy are the existing European requirements to offset environmental impacts as indicated in the Habitat Directive (HD), Art. 4 (subdivision 3 and 4), and the Wild Birds Directive (WBD) of 1979 (79/109/EEC amended into the 2009/147/EC). Although the WBD states the willingness to protect bird species and their habitats, it does not require compensation for impacts by itself but through the Environmental Impact Assessment Directive (EIAD) (85/337/EEC). The articles 12 and 16 of the EIAD conditions projects impacting protected species and animals (listed in Annex IV) to be authorized only when no other alternative exists, it override public interest (Article 16[1]), or the related impacts do not impede maintaining a favorable conservation status of the species concerned (European Commission, 2007). On the other hand, the Habitat Directive (HD) of 1992 (92/43/EEC) Art. 6[3] and 6[4] also require compensation to projects with significant environmental impacts jeopardizing priority conservation areas, i.e. the Natura 2000 network of Special Protection Areas (SPA), Sites of Community Interest (SCI) and Special Areas of Conservation (SAC).

The problem with the concrete execution of the environmental compensation on the ground accordingly to the HD, WBD and the EIAD, and the limited results to help reduce the loss of ES due to LUC in Europe are related to 1) the features to consider such impacts ‘significant’ in order to require legal compensation, 2) the lack of methodologies to assess the impacts, and 3) the guidelines or strategies to plan and fund the compensation of the identified impacts. The past lack of strategies, policies and incentives in Europe to direct environmental impacts compensation towards a MBI delayed the development of innovative schemes for biodiversity offsetting in most of the European countries, including Italy. Recently, the EU has encouraged MS to develop new forms of compensation to tackle the loss of ecosystem services, habitats and species through the European Biodiversity and NNL Strategy. Now, the problem includes the lack of scientific knowledge to understand the different types of biodiversity offsetting, the key elements to develop a sustainable market-based instrument for environmental impacts compensation (as the governance, related institutions and stakeholder's functions), and the understanding of the methodologies to assess the impacts and design the compensation.

In synthesis, the problems addressed in this research study are the following:

Problem 1. Requiring compensation for impacts under the European Directives

The lack of rules to identify the impacts and classify them as 'significant impacts' to require legal compensation.

Problem 2. Assessing the impacts

The lack of standard scientific methodologies to assess the environmental impacts.

Problem 3. Designing the compensation projects

The lack of guidelines or strategies to plan and fund of the compensation projects. As well as the identification of the receptor sites and their long-term maintenance.

Problem 4. Understanding market-based biodiversity offsetting tools

The need of scientific knowledge to understand the development and enforcement of innovative schemes as MBI to address the compensation of environmental impacts related to the land use change associated with development projects.

The first three problems relate to the implementation of the European Directives linked to Environmental Impacts Compensation and the gaps between the theory of the regulations and the practice to implement them and contribute to the EU

Biodiversity and NNL Strategy. Whereas, the fourth problem relates to the need to the scientific background to develop and implement a new form of environmental impacts compensations scheme in line with the concept of PES and its implementation in a market-based instrument for BO.

1.3 Objectives and research questions of this study

In the light of the increased awareness about the loss of ecosystem services, habitats and species due to the European land use change and the need of tools to tackle this issue, the overall aim of this research is to extend the scientific knowledge about the use of Biodiversity Offsetting Schemes as an instrument to regulate and direct PES to deliver compensation for environmental impacts.

This study has identified the following three specific objectives related to the previous four presented problems to first, understand the current European regulations and mechanisms for environmental impacts compensation. And second, to fulfill the need of scientific knowledge to develop and implement a new market-based biodiversity offsetting as a tool to compensate for the loss of ecosystem services due to the land use change by development projects.

The specific objectives and related research questions of this research are the following:

Objective 1. Study the EU regulations and methodologies used to compensate for environmental impacts due to the land-use-change related with development projects.

> 1a) What are the regulations at European level that require compensation of environmental impacts related to the land use change due to development projects.

1b) What are the leading regulations implemented at country level that derived from the EU regulations?

1c) What are the challenges and limitations of such country level schemes and/or programs and/or mechanism to help tackle the loss of ES in Europe and to develop a market-based instrument of BO?

Objective 2: Study the components of biodiversity offsetting as a market-based instrument for environmental impacts compensation.

2a) What are the impacts assessing methods of biodiversity offsetting and biodiversity banking?

2b) How the assessing methods are applied to empirical cases of impacts and the design of compensation projects?

2c) What are the institutions and stakeholders related in biodiversity banking, what is their role and function?

Objective 3: Analyze the similarities and differences between the biodiversity offsets in USA and Europe to learn from the most experienced schemes and develop a biodiversity banking model to be applicable for Italy.

3a) What are the differences between the European efforts to compensate for environmental impacts and the American mechanism for biodiversity offsetting?

3b) What are the Italian regulations for environmental impacts compensation and the current schemes of biodiversity offsetting?

3c) What are the challenges and limitations to be faced in Italy to develop and implement a biodiversity banking scheme?

1.4 Research structure

This thesis is structured in 3 Parts and 9 Chapters as follows:

Part I FUNDAMENTS includes Chapter 1, 2 and 3.

Chapter 1 introduces the subject matter of this study, the problem statement and the research objectives and questions. **Chapter 2** provides a theoretical background about methods and mechanisms used for environmental impacts compensation, the biodiversity offsetting definition, the types of BO mechanism in general, and in concrete, the characteristics of MBI for biodiversity offsetting. **Chapter 3**, Material and methods, presents the research design and approaches used to address the problems that gave origin to the objectives of this research.

Part II RESULTS AND DISCUSSION includes Chapter 4, 5, 6, 7, 8 and 9.

Chapter 4 explains the European regulations related to the compensation of environmental impacts and presents some examples of regulations enforced in Member States of France, Spain, England and Germany. Later, **Chapter 5** analyzes the methodologies used in biodiversity offsetting to assess the environmental impacts and design the compensation projects, including the impacts unit of measure, and the compensation project price estimation.

Chapter 6 proposes a metrics tailored for the case of Italy and exercise its empirical application in the case study of the high-speed roadway *Pedemontana Veneta*. Following, **Chapter 7** studies the components of biodiversity offsetting as a MBI in theory and analyses the case of the American Conservation and Mitigation Programs (referred as US BO schemes) to understand the empirical use of market-driven schemes of BO, including its governance, related institutions and stakeholder's functions. **Chapter 8** analyses the gap between the biodiversity banking and the European initiatives towards environmental impacts compensation and NNL. Finally**, Chapter 9** analyses the case of Italian legislation and its readiness to develop and implement a market-based instrument to compensate for the LUC derived from development projects.

Part III CONCLUSIONS presents the conclusions of this thesis.

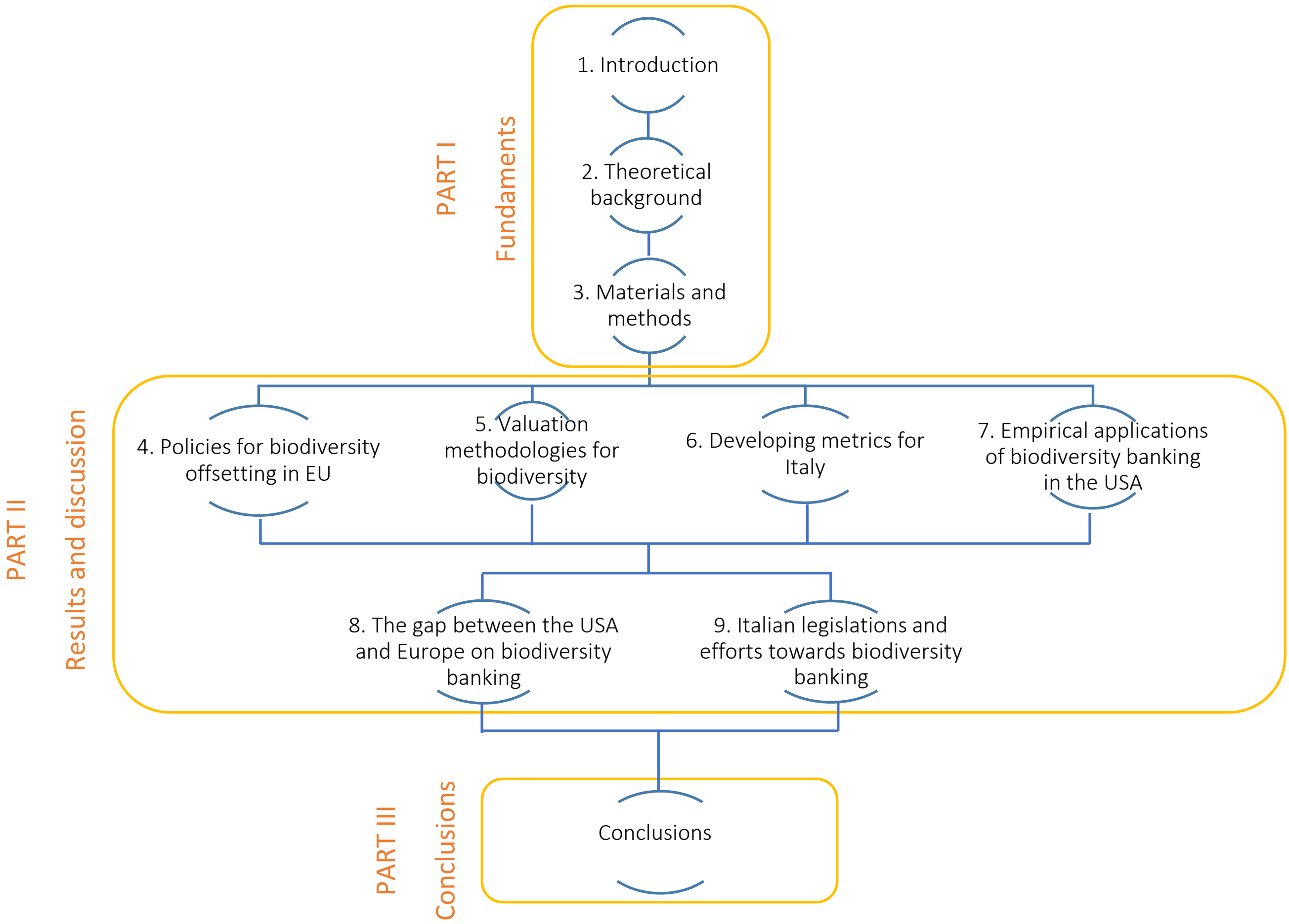

Figure 1. Graphical representation of the thesis structure

CHAPTER

TWO

THEORETICAL BACKGROUND

There are different schemes and tools used to implement environmental impacts compensation. First, this chapter defines the mitigation hierarchy and describes the concept of offsetting. Then, defines Biodiversity Offsetting (BO) and presents the different regulated and voluntary tools that can be used to offset environmental impacts, including the market-based mechanism used in BO. This chapter helps to understand the different market-based mechanisms for environmental impacts compensation including the features that characterize advance mitigation, which in this study is referred as Biodiversity Banking (BB).

2.1 The mitigation hierarchy

The mitigation hierarchy is essentially the most known tool used along the project planning and programming that allows to identify the project's environmental impacts and helps recognizing the options to avoid and minimize, as far as possible, the negative impacts applying the following steps of the mitigation hierarchy (Madsen, et al., 2010):

1- **Avoidance** of the impacts at planning stage,
2- **Minimization** of harm, i.e. reduce the duration intensity and/or extent of the impacts,
3- **Restoration** using the primary remediation on-site,
4- **Compensation** of the impacts, i.e. give back the natural resources and services towards their not net loss on the environment off-site or in-site, when possible,
5- **Offsetting** indicates a particular type of conservation actions that can be seen as measurable conservation outcomes achieving no net loss and preferably a net gain of the ecosystem services lost. Offsetting occurs off-site the injured area. Net gain means reaching a higher level of natural resources and services going beyond its baseline.

The avoidance step is essential at the beginning of the project planning to prevent, as far as possible, environmental impacts derived from the development project. After avoiding most of the impacts, the minimization step seeks to reduce the duration and intensity of the identified impacts. After this two first steps of the mitigation hierarchy, all still existing environmental impacts that will occur due to the development project are called **unavoidable residual impacts**. The last three phases of the mitigation hierarchy are used to identify and possibly quantify that unavoidable residual impacts seeking for actions to recompense the environment for the caused damage.

The mitigation hierarchy addresses the recompense of the unavoidable residual impacts by the step 3, 4 and 5, i.e., through restoration, compensation and offsetting. Distinguishing the difference among this three terms is crucial. For this research, **restoration** has the same meaning that remediation and rehabilitation, i.e. measures taken to restore *in-situ* the injured resources and services towards their pristine condition (baseline). Thus, restoration can also be called *primary remediation,* so returning the damaged natural resources or impaired services towards their baseline condition on-site.

The baseline condition is referred as *No Net loss*. It means reaching the level of ecosystem services that would have occurred without the ecosystem injuries but including natural and anthropogenic changes on the ecosystem services unrelated to the injuries (Dunford et al., 2004).

Now, the terms *offsetting* and *compensation* are frequently interchangeable terms, however, the offsetting concept is well distinguished from compensation when talking about Biodiversity Offsetting (described in section 2.2) (Conway, et al., 2013; Madsen et al., 2010; ten Kate et al. 2004). **Compensation** measures are actions seeking to give back the natural resources and services towards not net loss on the environment. Such actions are preferably planned to compensate on-site, i.e. within the injured area whenever possible. On the other hand, **offsetting** is led by the compensation actions (step 4 of the mitigation hierarchy) aiming to achieve a higher level of natural resources and services going beyond its baseline, i.e. achieving a *net gain*. Thus, the compensation projects seeking to reach no net loss and preferably a net gain over the ecosystem services baseline are referred as **Biodiversity Offsetting** (BO) and they often occur off-site the injured area.

Biodiversity Offsetting occurs when primary remediation, i.e. restoration, do not result in the complete rehabilitation of the environmental injuries. Therefore, BO carries out ***complementary*** and ***compensatory remediation*** measures to compensate for the permanent and temporary impact. Complementary remediation measures occur off-site the injured area and compensate the permanent impacts by providing a similar level of the natural resources or services (Hood, 2012). Compensatory measures recompense for the interim losses, i.e. provide compensation for the natural resources and services pending recovery during the restoration period, either on-site or off-site the injured area (Hood, 2012; Martin-ortega et al., 2011).

The following figure illustrates the application of the avoidance and minimization steps during the development project's planning phase (A). And the consideration of the restoration, compensation, and offsetting of the residual environmental impacts (B).

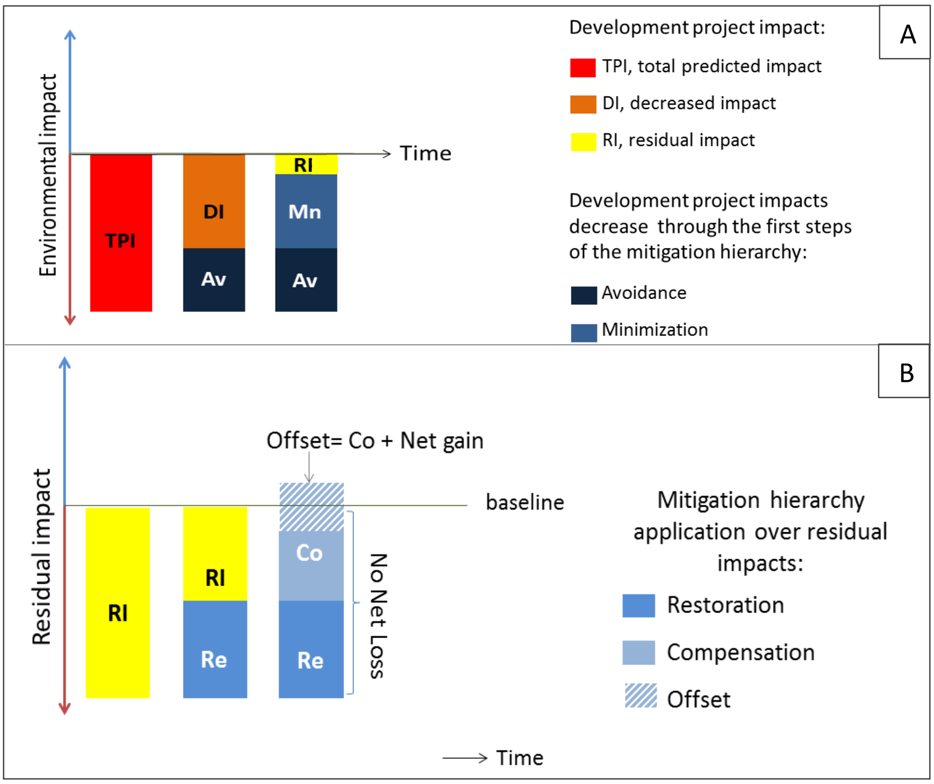

Figure modified from ICMM, 2005

Figure 1. Steps of the mitigation hierarchy

It has been a common practice to accept projects' residual social and environmental impacts in exchange for the economic benefits of jobs and revenue that accompanied them (ten Kate, 2013). The expectations for receiving net social, environmental and economic gains, were often considered greater than the impacts on the environment. At present, developers in advanced countries like the USA and Europe, and in other developing countries like Mexico and Colombia (Madsen, et al., 2011), currently need to demonstrate that their project will have minimum negative impacts on the environment. In the USA even the residual unavoided impacts are assessed to be adequately compensated through Conservation Banking and Mitigation Banking Schemes.

The Forest Trends Organization (2013) states that there are three principal motivations for developers to demonstrate no net loss or net gain of social and environmental values: 1) to comply with legal requirements for offsets or compensation now enforced in over 45 countries and under development in another 27 (Madsen, et al., 2011) and/or the Environmental Impact Assessment (EIA) a planning law in many more countries; 2) the voluntary business case for no net loss, which although not legally required, offers a potential attraction to developers (TEEB, 2010); and 3) to meet investors requirements.

2.2 Definition and features of Biodiversity Offsetting

Biodiversity offsets are defined as measurable conservation[1] outcomes resulting from actions designed to compensate for significant residual unavoidable impacts arising from developments project after appropriate prevention and mitigation

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[1] Conservation here is considered as in-situ according to Article 2 of the Convention on Biological Diversity: "In-situ conservation means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties."
http://www.cbd.int/convention/articles/default.shtml?a=cbd-02

measures have been considered (ten Kate, et al., 2004). The goal of biodiversity offsets is to achieve no net loss and preferably a net gain on the ground on the ecosystem services, goods, and functions associated with biological diversity (ten Kate, 2013). Biodiversity offsetting often occurs off-site the injured area and include complementary and compensatory remediation measures to compensate for the permanent and temporary unavoidable residual impacts of development projects (Hood, 2012; Martin-ortega et al. 2011).

In biodiversity offsetting, *biodiversity* is defined as the genetic diversity within species, species diversity within ecosystems, and ecosystem diversity across landscapes. Also, *biodiversity values* refer to all direct (consumptive and productive) and indirect (economic, ethical, educational, aesthetical and scientific) values of the biodiversity that support several ecosystem functions vital for human well-being, such as agricultural crops, timber, medicinal plants and industrial raw materials, air and water purification, climate regulation, and provision of recreational opportunities (Pearce & Moran, 1994). Thus, biodiversity and biodiversity values can be looked as important indicators that can provide a unit of measurement of the environmental impacts that BO aims to compensate.

Biodiversity Offsetting is a potential tool for achieving the objective of no net loss, and preferably, net gain of biodiversity values during development projects. The developer is then identified as the liable party and is responsible for the compensation of the unavoidable residual impacts that remained after the execution of the first two steps of the mitigation hierarchy, i.e. avoidance and minimization. The residual impacts might then be restored, compensated and offset using primary, complementary and/or compensatory remediation measures.

The residual environmental impacts comprise all natural resources and services injured that are lost temporary or permanently in consequence of the development project. The temporary losses also referred as interim losses, are those that after the execution of the compensatory remediation measures, will eventually[2] recover and reach the baseline level. On the other hand, the permanent losses are the natural resources and services that are entirely lost and will never be recovered. Under this circumstances, the party and the competent authority pursuing or authorising the development project may determine the compensatory remediation measures needed to compensate and possibly offset the permanent and interim losses (steps 4 and 5 of the mitigation hierarchy).

2.3 Market-based instruments and biodiversity offsetting

The policies to protect the environment set one goal and identify and enforce means to achieve that goal. The goal and the means are the two components that lead the policies for environmental matters (Stavins, 2001). This section focuses on those 'means' and presents the different categories of market-based instruments that are used in environmental policy.

According to the definition given by Robert Stavins (2001), MBI is regulations encouraging the desired behaviour by means of market signals rather than the direct enforcement of explicit directives regarding the environmental issue to be controlled.

The types of MBI currently in use for biodiversity protection can be divided into four categories: pollution charge systems, tradable permits, market friction reductions and government subsidy reductions. These categories currently lead the market-based environmental policy instruments, known as economic-incentive (Stavins, 2001).

[2] The recovery time-profile of the injured natural resources and services, depending on their extent and gravity, is an issue of crucial importance when planning and scaling compensation measures. The different recovery time-dimension of the injured resources is being a subject of research and debate (Howe, 1990; European Commission, 2001; Ofiara, 2002; Boyd, 2000; Defrancesco et al., 2008).

1. Pollution charges systems. Also called priced-based system. These are the most antique and widely MBI used is the pollution charge system (Pigou, 1920). It uses taxes/charges/fees, on the amount of pollution or environmental issue that a firm or source generates. The challenge with this system is to identify the appropriate tax rate according to the environmental issue that wants to be controlled (Stavins, 2001).

2. Tradable permits. Also known as, quantity-based permits are MBI under which an allowable quantity of level of pollution or impacts over the environment as water pollution or land use change is established and traded among the users needing to have such impact on the environment due to their activities. Tradable permits operate by creating a market for permits that allow engaging in an activity by restricting the quantity of this activity /a cap or a floor level allowed). For example, limiting the amount of activity that in excess is damaging to the environment as the greenhouse gases emissions, fishing, or impacts on the environment due to the development project. Examples of these instruments are the cap-and-trade, credit program, offsets schemes, tradable development rights (Stavins, 2001; eftec-IEEP et al., 2010).

3. Market friction reducing instruments. These operate by improving the functioning of an existing market, but can always involve developing an entirely new market. Some examples are: a) market creation, b) liability rules by contracts/stewardship payments, debit for conservation swaps, and c) information programs by differentiating products through eco-labelling and or certifications (Stavins, 2001; Prokofieva et al., 2009; eftec-IEEP et al.,2010).

4. Government subsidiary reductions. These instruments are the opposite of pollution charges systems. In this case, instead of having a payment-based system for a particular environmental impacts, the government provides

subsidies, taxes reduction or grants to incentivize good environmental practices (Prokofieva et al., 2009).

Considering these definitions of the different types of MBI for environmental policy, it can be said that Biodiversity Offsets are a quantity-based instrument. When a particular type and amount of environmental impact on the environment is allowed by the permitting authority for the execution of a development project, this authority becomes the legal figure that can require compensation for that type and amount of environmental impact. Such impacts can be quantified and qualified by a set of methods (called metrics and later discussed in this thesis in Chapter 5) and measured in a unit commonly known as 'debit' in biodiversity offsetting. In this way, the metrics become the measurement unit of the impacts, and those can be compensated with positive impacts on the environment called 'credits'. In this way, the compensation of the environmental impacts can be delivered through a market-based biodiversity offset, where the credits to compensate for the debits are exchanged from the supply side (landowners supplying the environmental credits) to the demand side (the developer causing an impact on the environment, debits).

2.4 Payment for Ecosystem Services for a market-based biodiversity offsetting

In a market-based biodiversity offsetting, the environmental impacts are compensated by the exchange of 'credits' that deliver positive impacts on the environment preferably in a relative ecological quantity and quality according to the impacts identified by the execution of the mitigation hierarchy. As defined in section 2.1, biodiversity offsetting occurs using complementary and compensatory compensation, i.e. by actions to compensate for the permanent and temporary impacts. The complementary remediation measures occur off-site the injured area and compensate the permanent impacts by providing a similar level of the natural resources or services (Hood, 2012). Compensatory measures compensate for the interim losses, i.e. provide compensation for the natural resources and services pending recovery during the restoration period, either on-site or off-site the injured area (Hood, 2012; Martin-ortega et al. 2011).

Biodiversity offsetting aims to achieve no net loss and preferably a net gain of the ecosystem services, goods, and functions impacted by the development project (ten Kate, 2013). The means through which biodiversity offsetting can achieve such goals is by compensatory and complementary remediation on-site and off-site the impacted area. Considering the 'off-site the injured area' component of BO, the offsetting actions can be delivered by a third party, that will quantify and qualify the positive environmental results of its land management to be exchanged as credits in the market of biodiversity offsetting. The party supplying credits for the market of biodiversity offsetting can be rewarded by a payment for its delivered ecosystem service; such payment will be covered by the impacting party, i.e. whoever is executing the development project.

Payment for Ecosystem Services (PES) are "voluntary transactions where a well-defined environmental service (ES) or a land use likely to secure that service is being 'bought' by a service buyer (minimum one) from a service provider (minimum one), if and only if, the service provider secures the service provision (concept called conditionality)" (Wunder, 2005). Despite this definition, there are additional conceptualization issues within the definition of PES that arise from the difficulty of classifying and evaluating the meaning of a "well-defined ecosystem service" (Boyd and Banzhaf, 2007). Another issue with this definition is the strictly voluntary nature of the transaction. Several authors discuss the use of PES as a purely voluntary transaction or a government based transaction (Muradian et al., 2012; Sattler and Matzdorf, 2013; Vatn, 2010).

There is very little knowledge about the correctness of using PES within biodiversity offsetting, and whether the payment would be voluntary or mandatory.

However, the concept of delivering a payment to a provider (group or individual) for the delivery of an environmental service can become a powerful mechanism to create a market for credits that would compensate for environmental debits of developers within biodiversity offsetting.

2.5 Defining Biodiversity Banking

Biodiversity Banking (BB) originated from the evolution of different forms of Biodiversity Offsets. As described by Bull et al. (2013), "offsets" encompass different mandatory policies or voluntary mechanisms with the common objective of compensating environmental losses through actions generating comparable biodiversity gains (ten Kate et al., 2004). The premise is that offsets are implemented as the last resort of the mitigation hierarchy and that NNL cannot be achieved without avoidance, mitigation and rehabilitation of the adverse impacts (BBOP, 2009; Froger et al., 2014).

From an institutional point of view, biodiversity offsets can be classified into three types: (i) permittee-responsible mitigation, (ii) financial compensation and (iii) biodiversity banking (Froger et al., 2014; Calvet et al., 2015).

(i) Permittee-responsible mitigation is also known as "in-kind" or "like-for-like" compensation. It consists of measures implemented to restore, rehabilitate, create or preserve habitats via direct ecological measures carried out by the developer, i.e. the project responsible obtaining the permit to perform land development. The permittee-responsible environmental compensation was conceptualized as "who pollutes pays" supported by ecologists and legislators (Morandeau and Vilaysack, 2012).

(ii) Financial compensation, also called in-lieu-fee, is a monetary transfer made from developers to agencies or other entities[3] to pay for the equivalent environmental losses. This offsetting evolved from the idea of enlarging permittee-responsible compensation into larger-scale compensatory actions by favouring the economies of scale concept, i.e. reducing transactions and management costs by collecting money first, and carrying out the offsets after sufficient resources are available (McCann, 2013). Financial compensation benefits from the flexibility given to offset after the environmental impact has occurred, when a suitable offsetting receptor site and the financial resources to manage it are available. Financial compensations have shown ecological equivalency issues related to the time gap between the impacts and actual offset, the lack of additionality, the underestimation of environmental losses, and the release of the developers' liability for the environmental impacts (Morandeau and Vilaysack, 2012)

(iii) Biodiversity banking started gaining popularity at the beginning of the 1990s as a result of the limited ecological outcomes of monetary compensation, and the high transaction costs of permittee-responsible offsets evidenced in the USA (DeWeese 1994, Marsh et al. 1996, Redmond et al. 1996, EDF 1999; Calvet et al., 2015). The biodiversity banks are the pieces of land devoted to environmental conservation using restoration, rehabilitation, enhancement, and or ecosystem creation in advance (ex-ante) of the environmental impacts of development projects.

Biodiversity banking can also be defined as a market-based BO that delivers environmental service benefits provided by landowners (supply side of credits) in ex-ante the development project's impacts (demand side). The ecosystem services provided to offset the impacts are commonly measured in the unit of 'credits' and exchanged into a market, a 'biodiversity market' (eftec-IEEP et al., 2010;

[3] Depending on the country, entities can be local, regional or federal governmental agencies or other type fund managers.

Environmental Bank, 2012). The credits are calculated considering a set of features and characteristics of the natural resources and/or services expressed by a set of the single attribute's measurements known as the metrics (addressed in Chapter 5). Such metrics must reflect the gains, losses and/or conservation of the environmental goods and services that are being exchanged (Madsen et al. 2011; Conway et al., 2013).

In this study, BB embraces all supply offset schemes functioning with an intermediary structure, i.e. the for-profit biodiversity banks, or the non-profit entities owning or managing land where compensation measures take place. For example, mitigation banking and conservation banking in the USA; biodiversity credit banking in the UK; compensation supply in France, etc. The biodiversity banks are established in a particular piece of land managed to create, enhance, restore and/or preserve environmental assets that offset, off-site and ex-ante and preferably in-kind, the adverse impacts of development.

BB schemes allow multiple projects with like impacts to compensate in one ecosystem-comparative location. Such sites become a biodiversity bank strategically managed with two main purposes: 1) to reduce financial and time-cost of the compensation actions. The ability to focus conservation efforts on fewer, larger, strategically located mitigation sites, is thought to greatly increase the chances that the compensation measures will be more likely to achieve ecological and business success because the BB is managed to reach ecological performance goals and economic return expectations (Denisoff, 2008);and 2) to reduce the transaction costs involved in the impact-compensation matching process that developers and agencies go through. BB offers a novel solution for achieving substantial impact compensation by incentivizing environmental businesses to preserve habitats and species.

CHAPTER

THREE

MATERIALS AND METHODS

The methods used in this thesis vary according to each objective and related research questions that are answered in the different chapters of this thesis.

The **Chapter 1** briefly introduces the background of this research, and the problems encounter that this thesis aims to solve through the statement of the objectives and research questions.

The **Chapter 2**, 'Theoretical Background', of this thesis was stated after an exhaustive literature review about biodiversity offsetting using the Scopus database, and gray literature linked to reports and articles of country-level institutions web pages, as the Italian National Institute for Environmental Protection and Research, ISPRA, (*Istituto Superiore per la Protezione e la Ricerca Ambientale*), the US Fish and Wildlife Service (USFWS), and the French Ministry of the Environment. Also, some other research institutes were consulted as the Forest Trends Association and the Business and Biodiversity Offsets Programme (BBOP).

The chapters reporting the results of this thesis (Chapters 4, 5, 6, 7, 8 and 9) followed specific methodologies as described below. It is worth to mention that, Chapter 8 discusses the results of Chapter 4, 5 and 7 and it recalls some information collected through the literature review for a better understanding of the concepts discussed.

Table 3 synthezises the research framework of this thesis according to each objective and summarizes the methodology followed in each chapter.

The **Chapter 4**, 'Policies for biodiversity offsetting, collected information from scientific and grey literature to study the EU Directives that give the basis for the development of a new type of environmental compensation scheme in EU and presents the legislations of France, Germany, Spain and England that regulate biodiversity offsets. Scientific and grey literature were analyzed to collect information from official websites such as: the Regulatory In-lieu fee and Bank Information Tracking System (RIBITS) in the USA; the Department of Environment, Food and Rural Affairs (DEFRA) in the UK; the Ministry of the Ecology, the Sustainable Development and the Energy (MEDDE) in France; the Institution for the Protection and Environmental Research (ISPRA), and the Ministry of the Environment, Land and Sea of Italy; and the Bavarian State Office for the Environment in Germany.

Additionally, some semi-structured interviews to key informants were executed to collect updated information about the French, German, Spanish and English initiative of MBI for biodiversity offsetting. Below, in "Chapter 9", the research framework used to organize the semi-structured interviews is presented.

The **Chapter 5**, 'Valuation methodologies for biodiversity banking: the metrics', studies the most applied methods used in environmental impacts compensation due to development projects and environmental damage assessment from scientific papers and scientific reports published by scientific associations like the Institute for European Environmental Policy (IEEP). This chapter analyzes the methodologies used in biodiversity offsetting to assess the environmental impacts and design the compensation projects, including the impacts unit of measure, and the compensation project price assessment.

The **Chapter 6**, 'Developing metrics for Italy'. A study of the English methodology to assess environmental impacts was carried using official material form the Department for Environment, Food & Rural Affairs. Consecutively, information about the Italian habitats and Natura 2000 sites was collected from the ISPRA and the European Environmental Ministry to customize the DEFRA's metrics for the Italian environmental and habitat features and apply it to the empirical case study of the High-Speed Road *"Pedemontana Veneta"*. A collection of official data about the

Pedemontana Veneta case-study was collected through the Veneto Region to consult the Ecological Impact Assessment of such project. A deep analysis of the information collected and a consultation with key experts was executed for the elaboration of this chapter. In this chapter, ArcGIS® and Excel™ software were the main instruments used to assess the empirical impacts of the case study and to proposes two different potential offsetting projects. Annex 4 presents the Excel calculation model used in this Chapter.

The **Chapter 7**, 'Empirical application of biodiversity banking in the USA', And **Chapter 8,** 'Breach between the USA and Europe on Biodiversity Banking'. Chapter 7 deepens in the application of the Conservation and Compensation Banking Schemes in the USA to understand these schemes' governance, related institutions and stakeholders' functions. To collect information for Chapter 7 and 8, a field research was conducted in California, Texas and Florida; and in France, the UK, Germany, Spain and Italy. Face-to-face, voice-call, semi-direct open interviews and field visits were conducted with environmental agencies, practitioners, consultants, lawyers, and researchers (Table 1). 49 face-to-face/voice-call semi-direct interviews were conducted: 14 regulators, 13 bankers, 5 consultants and 18 lawyers or researchers. Nearly 92% of the interviews took place in California because its length of experience with BB. France, the UK, Germany and Italy exemplify different implementation of BB, going from experienced schemes in Germany, new development and piloting schemes in Frances, the UK and Spain, and to research-level regional BB-like mitigations in Italy.

The stakeholders interviewed were selected based on their role in governmental or non-governmental entities regarding BB and other forms of offsets. The uneven number of represented roles in all studied countries is due to the heterogeneous knowledge distribution on biodiversity offsetting, i.e. in the USA there are more agency staff members and practitioners with knowledge on the empirical use of BB that were willing to participate in our study than there were consultants and academics. In other countries like France, the UK, Germany and Italy there is limited knowledge on biodiversity banking. Therefore there were not as many people available to participate in this study.

The interviews were carried out to collect data about the current policies and empirical practices of the American and European mitigation and compensation offsetting mechanism used in Chapter 8. Scientific and gray literature were also analyzed to collect information from official websites such as: the Regulatory In-lieu fee and Bank Information Tracking System (RIBITS[4]) in the USA; the Department of Environment, Food and Rural Affairs (DEFRA) in the UK; the Ministry of the Ecology, the Sustainable Development and the Energy (MEDDE) in France; the Institution for the Protection and Environmental Research (ISPRA), and the Ministry of the Environment, Land and Sea of Italy; and the Bavarian State Office for the Environment in Germany.

Table 1. Sample of interviewed actors.

Role	*Number of actors*				
	USA	*Europe*			
		DE	*FR*	*IT*	*UK*
Regulator	9		2	3	
Banker	10		2		1*
Environmental consultant	3		1		1*
Other (lawyer or researcher)	5	2	6	2	3
Total	**27**	**2**	**11**	**5**	**4**

*The interviewee's role has the function of banker and environmental consultant at the same time and account for one person in the total number of interviews.

[4] RIBITS, the Regulatory In-lieu fee and Bank Information Tracking System was developed by the USACE supported by USFWS, National Marine Fisheries Service (NOAA), and the Environmental Protection Agency (EPA) and Federal Highway Administration to provide better information on mitigation and conservation banking and in-lieu fee programs across the USA.

Section 7.4 of Chapter 7, 'The US Conservation Banking implementation practicalities and challenges', presents the results of a field survey carried out to study the issues relates with the American Conservation Banking Program. The objectives were to assess the positive factors and pitfalls of Conservation banking in the USA, from the point of view of agency staff members (regulators), and practitioners (bankers). The study was based on the investigations previously realized at the University of California Davis in 2013 (Bunn et al., 2013) for the California Conservation Banking Program. The fundamental premise for enlarging this study in this thesis was that a USA nationwide study would give a more reliable data of the limiting factors and positive features of the Federally implemented Conservation Banking Program.

An online questionnaire was sent to 34 bank sponsors of approved Conservation Banks in the USA and 20 agency staff members from different States. A total of 11 practitioners, 34% response rate, was received after three months of data collection and active online survey. In total, 20 CB were represented from the States of Utah, Texas, Florida and California (Figure 2). While eight regulators participated in this study (40% response rate) from the Agencies of California Fish and Wildlife, US Army Corps of Engineers, Colorado Department of Transportation, Natural Resources Conservation Services, and Santa Cruz Planning Department.

Figure 2. Practitioners response information and distribution.

The questionnaire was elaborated and distributed using Qualtrics (Qualtrics, Provo, UT) online survey software. Annex 5 presents the list of questions sent to the regulators and practitioners. The survey questions were designed to: 1) Assess the criteria used by bankers and practitioners to create new conservation banks and identify challenges or factors hindering the banks creating process. 2) Assess the challenges and barriers to implementing an effective program nationwide. And, 3) identify policy changes that may help to improve the program.

Annex 6 presents the final report summarizing the survey results that was sent to all the participants of this study.

The source of the banks and banks sponsors data was collected from the following sources:

- Ecosystem Market Place Data Base for Conservation Banking of Endangered Species us.speciesbanking.com
- The National Registry for Conservation and Mitigation Banks of the Federal US Government: Regulatory In-Lieu Fee and Bank Information Tracking System Ribits.usace.army.mil/ribits_apex

The **Chapter 9**, 'Italian legislations and efforts towards biodiversity banking', reviews the current Italian legislation on environmental impacts compensation to collect information on the basis for the development of a biodiversity scheme. Also, as in Chapter 4, the data collected for this Chapter used semi-structured interviews to key informants to collect updated information about the current efforts in Italy towards a MBI for biodiversity offsetting.

Table 2 presents the research framework used to develop a set of questions that guided the semi-structured interviews. Such framework is based on previous research on ES considered by Corbera et al., 2009; Prokofieva and Gorriz, 2013; and Leonardi, 2015.

Table 2. The theoretical framework for biodiversity market qualitative interviews.

Specific objective addressed in the interviews	Dimension of analytical framework	Dimensions	Research questions
Elaborated from (Corbera et al., 2009; Prokofieva and Gorriz, 2013; Leonardi, 2015)			
Specific objective 1: Study the relationship between habitat and ecosystem services delivery with their management, governance and regulation scale	Ecosystem services	• Ecosystem type • Ecosystem benefits • Temporal feature with ecosystem service provisions and human consumption	• What are the ecosystem types that are been delivered for biodiversity mitigation? • What are the services attributes? • How are the attributes assessed? • Are there any environmental services provided by the ecosystem used for mitigation that offer other environmental benefits? What are those? • What are the temporal and space characteristics for

			biodiversity mitigation provision? • Do supply and demand coincide in space and time frame?
	Stakeholders	• Actors identification • Actors functions, rights and responsibilities • Actors interest, preferences and expectations • Actors information sharing • Lobbying	• Who are the actors directly related with the offsetting scheme? • Who are the indirect actor related? • What is the actor's role? • What are the actor's responsibilities regarding use, control and resources conservation? • How is the information collected and used? • Where the information come from and how is it shared? • Which are the coalitions sharing preferences for the use of management of resources? • Who are the actors participating in those coalitions? • What is the influence the coalitions have?

			• Are there any other weak coalitions or group of people sharing a preference?
	Policy and governance	• Policy • Agencies involved • Governance instruments	• Are there any regulations leading the demand side of offsets? • Where the service demand come from? • What are the options to comply with the demand? • Where is that supply coming from? • What are the governance instruments? • What are the agencies involved in the policy implementation? • How much information (e.g. data, predictive modeling skills) is necessary to design the policy instrument? • What is the extent to which the instrument is easy to be implemented?
	Institutions involved	• Institutions type • Contracts and procedures	• What are the institutions involved in the scheme?

		• Payments • Currency • Deliberation of the service	• What are the institutions role? • What are the proxies used to establish a payment? • What is the currency used to pay for the established value of the services offered? • Who decides what are going to be the management operations to achieve the offset and deliver such service? • What is the payment source, mode, currency, frequency, time, eligibility, equity with the biodiversity service provided, payment management and destination?
	Schemes scale and scope	• Scheme scale • Scheme human capacity scale • Scheme scope	• What is the scale of the scheme? • What is the scale of the environmental service provision? • Does an appropriate governance exist in the right scale? • What are the boundaries to consider in the mitigation provision?

			• Is the bundling and double tipping allowed? • What is the physical human resources needed to control the scheme? • What is the scope of the scheme?
	Scheme organization	• Monitoring and evaluation • Implementation complexity • Flexibility • Equity • Environmental effectiveness • Economic performance	• How are the project ecological, social and economic outcome measured? • If monitoring occurs, how often does it take place? And are the results available to the public? • What is the scope of monitoring? • Is the evaluation of the scheme taking place? • Is the scheme flexible enough to be applied in different places? • Is the cost of the provided service fairly equivalent to the cost of its implementation? • How is the payment distributed?
Specific objective 2: Identify the most important obstacles,	Political environment	• Opposition • Obstacles and challenges • Acceptability	• Which are the sources of conflict (i.e. divergent rationales, goals and

challenges or push backs related with biodiversity offsetting			implementation approaches)? • What actors are involved in the conflicts? • What is the awareness level of the scheme being needed? • What is the participation of actor or citizen's involvement in the scheme implementation, development or execution?
Specific objective 3: Study the scientific background supporting the implementation and enforcement of the offsetting programs in Europe.	Scientific background	• Success evaluation • Metrics	• Is the status of the scheme evaluated? • What factors are considered for the evaluation? • Has it been any research study on what type of metric to use for up-scaling the offset according to the impacts? • How that the metrics depend upon the ecosystem related?

Table 3. Thesis research framework, structure and methods

Objective 1	Research questions	Needed data	Source of information	Scale of analysis	Methodology	Outputs
Study the EU regulations and methodologies used to compensate for environmental impacts due to the land-use-change related with development projects	1a. What are the EU regulations requiring compensation of environmental impacts?	• Current regulations for environmental impacts in the European Union	• Literature	European Union	•Literature review	Chapter 4. Policies for Biodiversity banking 4.1 Notions of biodiversity offsetting in the EU policies
	1b. What are the country-level regulations addressing environmental impacts compensation in the Member States?	• Policies and tools implemented in Europe for environmental compensation • Key informants	• Literature • Case-studies • Interviews with key informants	France Germany England Spain Italy	•Literature review •Case-study selection •Semi-structured interviews with key informants	4.2 Country-level initiatives towards a market-based biodiversity offsetting in the EU
	1c. What are the challenges and limitations of the country-level schemes to tackle the loss of ES in Europe and to develop a MBI for environmental impacts compensation?	• Country-level schemes information • Key informants	• Literature • Case-studies • Interviews with key informants	France Germany England Spain Italy		Chapter 8. Breach between the USA and Europe on Biodiversity Banking 8.1 Lessons learned from the US BB

Objective 2	Research questions	Needed data	Source of information	Scale of analysis	Methodology	Outputs
Study the components of biodiversity offsetting as a MBI for environmental impacts compensation	2a. What are the impacts assessing methods of biodiversity offsetting and biodiversity banking?	• Regulated offsetting schemes data	• Key informants • Official documents • Desk analysis	• Global	• Literature review • Consultation with key informants	• Chapter 5. Valuation methodologies for biodiversity: the metrics
	2b. How the assessing methods are applied to empirical cases of impacts and the design of compensation projects?	• Metrics used in biodiversity banking	• English biodiversity offsetting methodology • Ecological Impacts Assessment of the High-Speed Road *"Pedemontana Veneta"*	• Europe-Italy	• Case-studies analysis in Europe, USA and Australia	• Chapter 6. Developing a metrics for Italy
	2c. What are the institutions and stakeholders related to biodiversity banking, what is their role and function?	• Experienced biodiversity banking scheme • Actors involved • Agencies involved • Institutional interactions • Actors functions and tasks	• Key informants • Scheme specific documentation	• USA	• Questionnaire and interviews with key stakeholders • Questionnaires and semi-structured interviews in California, Florida, and Texas in the USA.	• Chapter 7. The empirical application of biodiversity banking in the USA

Objective 3	Research questions	Needed data	Source of information	Scale of analysis	Methodology	Outputs
Analyze the similarities and differences between biodiversity offsets in the USA and in Europe to learn from the most experienced schemes and develop a biodiversity banking model to be applicable for Italy	3a. What are the differences between the European efforts to compensate for environmental impacts and the American mechanism for biodiversity offsetting?	• Biodiversity banking regulation in USA Biodiversity Banking Regulated offsetting schemes data	• Key informants • Official documents • Desk analysis	• USA and EU (France, England, Germany, Spain, and Italy)	• Literature review • Semi-structured interviews to key informants	• Chapter 8. The breach between the USA and Europe in biodiversity banking
	3b. What are the Italian regulations for environmental impacts compensation and the current schemes of biodiversity offsetting?	• Italian policies in environmental impacts compensation • Green Fund of Lombardy	• Key informants • Official documents • Desk analysis	• Italy	• Literature review • Semi-structured interviews with key informants • Case-study of the Lombardy's Green Fund of Lombardy	• Chapter 9. Italian legislation and efforts towards biodiversity banking
	3c. What are the challenges and limitations to be faced in Italy to develop and implement a biodiversity banking scheme?	• Actor, agencies and institutional interactions involved in the Italian compensation schemes	• Key informants • Scheme specific documentation	• Italy		• Chapter 7. The empirical application of biodiversity banking in the USA

Part II

RESULTS AND DISCUSSION

CHAPTER

FOUR

POLICIES FOR BIODIVERSITY OFFSETTING

This chapter aims to study the European Directives that are leading the development of a new type of environmental compensation scheme in the EU and presents the case of the legislations in Germany, the UK, France, Spain and Italy and their particular initiatives directed to develop a biodiversity banking-like scheme. First, this chapter aims to recognise the currently enforced EU legislations requiring environmental impacts compensation steps, second, study the Biodiversity and No Net Loss Strategy to identify the actions directing the development of a biodiversity offsetting mechanism, and third, to identify the country-level existing initiatives, their components and implementation features to analyze their similarity with a biodiversity banking scheme.

4.1. Notions of biodiversity offsetting in the EU policies

The European Union has reflected its commitment to reduce the impact on the biodiversity values by the creation of the "EU Biodiversity Strategy 2020" and the "No Net Loss" strategy. The Biodiversity Strategy requires all Members States (MS) to carry out actions that contribute to halving the current rate of biodiversity loss, and by the year 2020 to reach the restoration of 15% of European degraded ecosystems (European Commission, 2012). These strategies propose a set of actions to MS to achieve a set of specific targets.

The Strategy 2020 sets five targets being the target 1 and two the most outstanding for the development of biodiversity offsetting schemes in Europe. Target 1:*"To halt the deterioration in the status of all species and habitats covered by the EU nature legislation and achieve a significant and measurable improvement in their status[…]".* And, Target 2: "*By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.*" (European Commission, 2011). Most importantly, the Strategy 2020 invites MS to develop new instruments to achieve NNL, as for instance the use of market-based instruments. Action 7 invites MS to ensure no net loss of biodiversity and ecosystem services through, for example, compensation or offsetting schemes (European Commission, 2011). There is also a clear evidence that the European Union is working on the development of new measures that might become the start of a mandatory Biodiversity Offsetting Scheme for the Members States, as this action 7 mentions that the *"Commission will carry out further work with a view to proposing an initiative to ensure there is no net loss of ecosystem and their services"*.

The principle of NNL is also endorsed by the European Birds Directive (79/109/EEC) and Habitats Directive 92/43/EEC. Article 6(3) of the Habitat Directive requires appropriate assessment of any plan or project likely to have a significant effect on a Natura 2000 site and the Art. 6(4) requires compensation for the development impacts considered to damage the ecological integrity of Natura 2000 sites, which are considered essential for reasons of overriding public interest: *"[…] the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted."*

Furthermore, the Wild Birds Directive requires the MS "*preserve, maintain or re-establish a sufficient diversity and area of habitats for all the species of birds*" (Art. 3 2009/147/EC) and "*take appropriate steps to avoid pollution or deterioration of the habitats or any disturbances affecting the birds*" in Special Protection Areas (SPA), but also outside the SPAs (Art. 4, 4 2009/147/EC).

4.1.1 The role of the Environmental Impact Assessment

The Environmental Impact Assessment (EIA) is a procedure developed to evaluate the likely environmental impacts of a proposed project or development, taking into account beneficial and adverse inter-related socio-economic, cultural and human-health impacts (CBD, 2013). It aims to predict environmental impacts at an early stage in the project planning and design, find ways and means to reduce adverse impacts, thus shaping the projects to suit the local environment and present the predictions and options to decision-makers (CBD, 2013).

The EIA has being introduced for the first time in Europe with the Council Directive 85/337/CEE[5] and further amended three times in 1997[6], 2003, 2009 and finally codified by the Directive 2011/92/EU of 13 December 2011. The execution of the EIA is mandatory for all the development projects included in Annex I of the Directive (Art. 4,1 2011/92/EU). And, if the project proposed is not in Annex I, the Article 4 [2] encourages the MS to determine in which circumstances a project shall be made

[5] Directive 1985/337/CEE on the assessment of the effects of certain public and private projects on the environment. Available at http://ec.europa.eu/environment/eia/full-legal-text/85337.htm

[6] Directive 1996/11/CEE regarding the Environmental Impact Assessment mandatory for the public and private projects included in Annex I. Available at http://ec.europa.eu/environment/eia/eia-legalcontext.htm

subject to an EIA. In this way, MS have freedom of authority to enforce or not the legislation that would channalize environmental compensation. This freedom of authority means that the concept of compensation appears indirectly in the EIA. The Article 5, point 3 (b) of this Directive sustains that the Annex I projects may present planned measures that follow the mitigation hierarchy. Therefore, it is a choice to require compensation is not made mandatory (Pileri, 2007).

The Action 19 of the Strategy 2020, a "*Biodiversity proof*" of the no net loss of biodiversity and ecosystem services, states: "*The Commission will continue to systematically screen its development cooperation action to minimise any negative impact on biodiversity, and undertake Strategic Environmental Assessments and/or Environmental Impact Assessments for actions likely to have significant effects on biodiversity*". This action reflects the EU initiative to enforce the EIA to minimise all significant effects on biodiversity, yet, at present, the main issues to enforce a legislation towards NNL are related to the lack of 1) a decision-making framework to ensure degradation is avoided wherever possible before compensation is envisaged (2020 Biodiversity Strategy, Action 7, 7a). 2) An overall non-binding framework at EU level providing guidance and exchanges of best practices for MS who have adopted voluntary or mandatory biodiversity offset policies, and 3) an EU level legal framework for NNL of ecosystems, which could make some of the above elements mandatory (ICF GHK and BIO Intelligence, 2013):

Moreover, in April 2012 the European Parliament adopted a resolution in which it states that it "*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; note, in this connection, the importance of applying such an approach to all EU habitats and species not covered by EU legislation*". With this, the Parlament admits the gap existing between the habitats and species that are currently covered by a compensation requirement but that are not filled to achieve NNL (ICF GHK and BIO Intelligence, 2013).

4.1.2 The role of the Strategic Environmental Assessment

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After the first EIA Directive 85/337/CEE the European Parliament and Council presented the Directive 2001/42/CE on the assessment of the effects of certain plans and programmes on the environment[7]. With this Directive the commitments go from specific to more general aspects related to the projects listed in the EIA. The SEA Directive applies to a wide range of public plans and programmes, and not only single projects like land use change, transport planning, energy, waste, agriculture, etc. It does not refer to policies, neither provide a list of plans/programmes similar to the EIA, on the other hand, it provides a mandatory procedure that must be executed before taking the decision of executing plans and programs that (Pileri, 2007; European Commission, 2012):

1) Are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste/ water management, telecommunications, tourism, town & country planning or land use, and which set the framework for future development of projects listed in the EIA Directive;

Or

2) Have been determined to require an assessment under the Habitats Directive.

Thus, SEA is a precautionary package to analyze the project and minimize their effect on the environment (Pileri, 2007; Mazzetti, 2006). Annex I of the 2001/42/CE (subsection g), that at the same time refers to the Article 5, *Environmental Report*, it is stated that compensation are "*the measures envisaged to prevent, reduce and as fully as*

[7] Directive 2001/42/CE on the assessment of the effects of certain plans and programmes on the environment. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:197:0030:0037:EN:PDF

possible offset any significant adverse effects on the environment of implementing the plan or programme".

Falter and Scheuer (2005) suggest that as the EIA, Strategic Impact Assessment (SIA) is strengthened in the Article 6 of the Habitats Directive since it provides the possibility to present the Commission with a complaint about real legal impacts. HD Article 6 (4) deals with offsets for the loss of habitats and species, by requiring compensatory measures and informing the European Commission of the measures taken. In the case of a site hosting a priority natural habitat type and/or a priority species, more stringent measures should apply, becoming the source of biodiversity offsets of projects and schemes (ICF GHK and BIO Intelligence, 2013).

In conclusion, as stated by Pileri (2007), the SEA does not address the concept offsetting *per se* because it is an instrument that functions after a vast analysis of the environmental impacts, and in a broader extension, the biodiversity values that need to be compensated. Such compensation must then be carried out with the same territorial scale that the programme/plan developed.

4.2 Country-level initiatives towards a biodiversity banking in the EU

In Europe, each MS has developed its compensation mechanism, and furthermore, different regions within one country can also follow diverse schemes. This section presents the legislation and initiatives at country or region level proposed as a tool for biodiversity banking (BB) in the countries of Germany, France, the UK and Spain.

Germany, the UK and France are the pioneers of BB in Europe before Spain and Italy (Chapter 9). In 1976, three years before the enforcement of the Wild Birds Directive (WBD), Germany and France had already introduced mandatory compensation requirements.

4.2.1 Germany

In Germany, the Impact Mitigation Regulation (IMR), *Eingriffsregelung*, was defined in the Federal Nature Conservation Act (GFNCA) independently of the Habitats Directive requirements (Darbi et al., 2009). Later, in 1993, the IMR was integrated with the Federal Building and Spatial Planning regulations introducing a BB mechanism, so-called "compensation pools" (*Flächenpools*) associated with "eco-account" (*Öko-Konten*). With the revision of the Nature Conservation Act in 2002, the German Federal States were empowered to introduce the eco-account for any impact under the IMR with the aim of providing areas for remediation in the urban environments (Naumann et al., 2008). Due to this absolute control by the public sector[8], there is not a private commercial functioning market for biodiversity credits up till now, although some private investors commence exploring it (BSOE, 2015a).

Recent data from the State of Bavaria registered over 2100 banking sites accounting for nearly 20,000 hectares of compensation and replacement areas[9] (BSOE, 2015b). Definitely, the scheme has introduced a new concept of compensation, but there are still essential elements needing attention to improve the long-term achievements for conservation, e.i. the perpetuity concept, long-term monitoring, ecosystem values equivalence between credits and debits through suitable metrics (Wenden et al., 2005; Jessel et al., 2006; Madsen et al., 2010; and Madsen et al., 2011).

4.2.2 The UK

On the other hand, in the UK no additional mandatory compensation requirements have been enforced yet on top of the current WBD, HD and EIA Directives. Nonetheless, the Department of Environment, Food and Rural Affairs (DEFRA) commenced exploring BB as one way to achieve the set goals of biodiversity

[8] 80% of all banks in Germany as still controlled by the public sector (Froger et al., 2014).
[9] Bavaria conserved an average of 2600 ha of land in the form of land-pool annually between 2008 and 2009 (Morandeau and Vilaysack, 2012; OECD, 2013)

conservation (DEFRA, 2011a) and to tackle further biodiversity loss (DEFRA, 2011b). The pilot metrics developed by the DEFRA and Natural England (2011) for accounting debits and credits, were tested in 6 pilot banking areas[10] for two years (2012-2014). With this voluntary pilot experience, DEFRA and related NGOs and private companies looked forward the outcome of a more effective and coherent standardized compensation strategy, and to persuade the private sector and local governments of the overall advantages of implementing BB through the country.

The two-year trial phase of BB in England have finished, and there has been limited information about the outcomes. According to an interim report to evaluate the pilot's halfway results (CEPL and IEEP, 2013), there was a lack of developers involvement and interest to implement an offsetting project. After all the piloting period, it has not been published much official information about the outcomes. It is yet unclear if any integration of BB will occur in the UK, and how the experience will be useful to develop a more streamlined compensation process.

Although the lack of mandatory offsetting voluntary compensations are occurring through private ecological consultancies. For example, Environment Bank is an English private company working on biodiversity compensation agreements for developers and landowners. Despite biodiversity offsetting has not been made mandatory, Environment Bank has made voluntary biodiversity offsets a reality in England (Environment Bank, 2012). Over 25 Local Planning Authorities across 15 counties involved with over 60 live planning applications have created a partnership with Environment Bank to receive individual support and implement their biodiversity offsets through the model of the exchange of debits and credits into a biodiversity banking scheme. The total credit sales of Environment Bank up to Spring 2016 brought €1.9 million to the rural economy in the counties of Essex, Cambridgeshire, Lancashire, Warwickshire and Oxfordshire. Environment Bank is helping small environmental impacts of low time, cost or environmentally effective compensation to be offset through habitat banks offering a

[10] Piloting Banks and metrics information available at https://www.gov.uk/biodiversity-offsetting

higher economic and ecologically effective compensation delivered by large areas of habitat creation or restoration.

4.2.3 France

Another country exploring BB schemes is France. The French State introduced the concept of avoiding, reducing and offsetting into its environmental legislation in 1976 with the Nature Protection Law (NPL, n° 76-629 of July 10th 1976) through the so-called *"séquence ERC".* Although for more than three decades the last step of the mitigation hierarchy remained neglected or "ill-applied" through the EIA (Quétier et al., 2014). Compensations started to become a binding element, at least on paper, in 2007 when the EU Directives were transposed into the French laws. This requirement resulted from the amendments to the natural NPL at the end of the two consultative processes (with agencies and civil society participating in 2007 and 2009) that lead to two sets of reforms for impacts of development projects.

In 2012, the French Environmental and Sustainable Development Ministry of the Environment (MEDDE) published guidelines (2012 b) on the use of BO after following modifications to the EIA and SEA (Decrees 2012-616 and 2012-995). The guidelines reiterate offsetting as a mechanism to achieve NNL through the ERC sequence policy (MEDDE, 2012a; and 2013). Although these principles, there is still little knowledge on the offsetting projects occurrence on the ground by private and public developers. This because the EIA application is derogated from the Environment Protection National Council to lower regional authorities, and even sometimes, to developers itself (Quétier et al., 2014). Consequently, different review teams are created (Cosnier, 2013) deciding when and how to require an offset hindering the NNL achievement.

In the light of learning from self-experiences, the MEDDE launched in 2008 the "biodiversity offset supply", an experimental biodiversity bank scheme providing offset credits for habitat, species and ecosystem functions (Calvet et al., 2015) delivered by public or private land. The French offset supply keeps developers responsible for the successful delivery of equitable compensation. Currently, the scheme has created one operating bank, the Cossure operation, implemented by the CDC Biodiversité[11] in Southeastern France. The bank extends over 357 ha of previously commercial orchards and helps addressing several environmental and economic issues: 1) the restoration of low grassland vegetation habitat of native bird species in the corridor of the Réserve Naturelle des Coussouls de Crau, 2) to encourage land-use planning improvements (Froger, et al., 2014), and 3) provide experience on the enforcement of NNL policies.

After more than 5 years of operation, the French first offset supply experiment has not been able to have enough credits demand. In 2011, MEDDE initiated a participatory process asking for proposal that should result in the launch of four more banks to get involved more landowners and developers (Froger, 2014). However, to date no more banks have been established and Cossure operation has offset a limited number of mostly private projects, because the lack of specific guidelines directing developers to acquire credits, the lack of incentives for landowners to create more banks, and hence, to be able to offer a wider variety of credit types supplied by different ecosystems.

4.2.4 Spain

As a response of the foreseen adaptive mechanism of the European Union on environmental impacts compensation, Spain has amended its Environmental Evaluation Law of 1988 (today 21/2013) to set the floor for BB development and implementation. This law now includes an additional disposition on BB (disposition 8 [4]) as a legal offsetting alternative by the acquisition of 'conservation credits' recognized by the Agriculture, Food and Environmental Ministry (BOE, 2013). Such

[11]CDC Biodiversité is the first biodiversity offsetting financial operator of biodiversity conservation. It was created in February 2008 as subsidiary of the French financial organization Caisse des Dépôts et Consignations (1816) (Froger et al., 2014).

credits would be voluntarily generated by landowners creating a biodiversity bank according with a set of rules yet to be published by the Environmental Ministry.

ECO@CSA is a private company founded in 2012 with the idea of starting Biodiversity Banking to protect biodiversity and reward local landowners of Spain for their environmental sustainable practices delivering ES. The model of Corporate Social Responsibility (CSR) has inspired ECO@CSA founders to offer developers green alternatives to compensate for their residual environmental impacts. Despite the government initiatives to incorporate the offsetting alternative in the Environmental Evaluation Law 21/2013, the lack of official guidelines and the current Spanish political environment have hindered the launch of biodiversity banking. In July 2016, the Extremadura Region expressed ECO@CSA their interest to plan a Regional Conservation Bank scheme. Extremadura is the 5th Region with more forest land and 30% of the total protected areas of Spain and one of the most advances Regions on environmental regulations. The advice of ECO@CSA to prepare a BB in Extremadura can become the milestone of BB in Spain and offer empirical experience on developing and implementing BB that can be further used by the National Environmental Ministry.

CHAPTER

FIVE

OFFSETTING VALUATION METHODS: THE METRICS

This chapter first explains what are the metrics and their role in biodiversity offsetting. Then it presents the current applied methodologies used to assess environmental impacts and to design biodiversity offsets, like Habitat Equivalence Analysis and other different metrics used in the English, Australian and American offsetting schemes. Finally, this chapter analyses the metrics dilemma to understand the difficulties of creating the basis of a new proposal for biodiversity offsetting and presents an adaptation of a metrics for the ecosystems in Italy and its application in an empirical case study of a development project in Northern Italy (Chapter 6).

5.1 Metrics in biodiversity banking

As seen in Chapter 2, Biodiversity Banking (BB) is a market-based mechanism where biodiversity credits are traded as a form of environmental compensation of impacts derived from development projects. Such credits are a measurement unit of the ecosystem services (ES) lost due to a development project (also called debits) that ideally will be compensated by equitable ES-derived from an offsetting project (credits), or a biodiversity bank also measured in that same credit unit. The difficulty in capturing all the ES traded means that the ecosystem itself is not a tradable market commodity, hence the need for proxies, metrics, to assess the ES into a standard unit of measurement, called 'credits' (Bull, et al., 2013).

The metrics are also identified as the '*currency*' of biodiversity banking that allows comparing credits and debits. These metrics are in essence ecological proxies can be divided in ***direct*** such as a set number of individuals of a particular bird or mammal species, or ***indirect***, as a surrogate of measures like the measure of habitat area, structure or complexity, or viability of the species of conservation concern. Consecutively, those can be ***aggregated*** measures that combine area and condition of habitat; or ***disaggregated*** such are the area of a particular habitat.

Choosing the metrics methodology and developing one is a crucial step in the design of a single biodiversity offset or a biodiversity banking scheme. The use of certain metrics depends for example on the availability of real biodiversity data and knowledge of the ecological context at the scale of the offset impact (local, regional or site-level, i.e.) (BBOP, 2012). This chapter presents different environmental impacts assessing methodologies and finalize by proposing a metrics to assess impacts and design offsets in Italy.

5.2 Resource-based equivalence approaches

In the USA non-market valuation methods as travel cost, hedonic, contingent valuation and conjoint analysis (choice modeling) are often used to assess the compensation measures cost. These methods are value-to-cost equivalency approaches where the value of damage is used to design the remediation. Because the difficulties related with these non-market valuation approach (value-to-cost), another kind of procedures based on the assessment of the impact resources were developed in the USA under the Natural Resource Equivalency Analysis (NREA) (NOAA, 1996; NOAA, 2000) and started to be applied in cases of environmental damage.

Traditionally, the interim and permanent losses are compensated after the development project is finished[12] similarly as if it was a compensation for environmental damage. However, the BO goal is NNL through complementary and compensatory remediation measures (hereafter referred as the offsetting project) to offset unavoidable residual impacts of development projects (Chapter 2, section 2.1). In other words, residual impacts were, and sometimes still are, addressed by ex-post compensatory remediation measures, which are often designed by the application of damage compensation approaches as value-based equivalence methods and resource-based equivalence analysis.

The value-based equivalence methods are value-to-cost methods that assess the cost of the damage by using economic approaches as the Contingent Valuation and Travel Cost Method (Mitchell & Carson, 1989; Louviere, et al., 2000; Martin-ortega et al., 2011). On the other hand, the resource-based equivalence analysis aims to in-kind compensation, i.e. service-to-service compensation. This means that the ES and functions lost should be compensated with the same or similar ES and ecosystem

[12] Several case-studies and pilot projects around the world have compensated their impacts after the project is finished, i.e. the case of Anglo Platinum. 2009. BBOP Pilot Project Case Study. Potgietersrust Platinums Limited (PPRust). Johannesburg, South Africa. www.forest-trends.org/biodiversityoffsetprogram/guidelines/angloamerican-case-study.pdf

functions. ES can be fishing, hunting, boating, hiking, bird watching, flood control, shoreline storm protection, and enjoyment of a healthy and function natural environment. While, ecosystem functions are the services delivered to ecosystems and other ecological resources, including habitat for food, shelter, and reproduction; organic carbon and nutrient transfer, biodiversity and maintenance of the gene pool (eftec-IEEP et. al, 2010).

As stated in the European Environmental Liability Directive, the resource based compensatory measures are preferred (ELD 2004/35/E Annex II 1.2.2 and 1.2.3) rather than the value-based equivalence methods because they avoid assessing the value people give to a given environmental site and quantify it in economic value, i.e. avoids giving a monetary value to nature. Flores & Thacher (2002) have discussed and suggested some advantages of the resource-based equivalence analysis as 1) it eliminates the problem of assessing the passive use values and non-use values paradigm (the example of the Exxon Valdez Oil spill damage assessment, Carson, et al., 2003). 2) Eliminates the ignorance/unknown value perceived from people to unfamiliar injured sites (Dumax & Rozan, 2011). 3) It allows reaching a better equivalence of the damaged environment since the compensation is estimated considering the level of the natural resources and services injured or lost by the incorporation of biophysical indicators (Martin Ortega et al., 2011). 4) It facilitates the legal procedure of environmental damage since the resource-based methods are preferred by the authorities (ELD 2004/35/E Annex II; NOAA, 1997; Thompson, 2002; Thur, 2007)

The resources-based equivalence methods commonly applied to provide in-kind compensation are the Habitat Equivalence Procedure, HEP; Habitat Equivalence Analysis, HEA, and the Resource Equivalence Analysis, REA[13] (Penn & Tomasi, 2002; Dunford et al., 2004; Tanaka, 2008; Dumax & Rozan, 2011). The main difference between HEP and HEA is the availability of data regarding the environmental impact. HEP calculates the compensation measures based on a hypothetical, or sometimes assessed by the EIA, environmental impacts of the development project, as it aims to scale compensation for future LUC due to development projects. While HEA, uses the data of the actual environmental impact as this method is often used on compensation after the impacts are made, i.e. environmental damage. On the other hand, the difference between REA and HEA is that the HEA assess only the habitat, while the REA includes all kinds of natural resources, as for example the number birds or sea turtles that were lost due to the impacts (Zafonte & Hampton, 2007). This chapter explores the applicability of HEA in the assessment of LUC related impacts through the identification of the ES delivered by the injured habitats (see also section 5.2.2).

5.2.1 Habitat Equivalence Procedure

Habitat Equivalence Procedure (HEP) (USFWS, 1980) is a resource-based valuation method, (Schamberger & Krohn, 1982) that bases the environmental impacts estimation on hypothetical compensation (Dumax & Rozan, 2011). The HEP aims to calculate ex-ante the scale of off-site compensation measures when the initial state of nature is known but the final environmental condition after the development shall still be predicted. As stated by Tanaka (2008) "*HEP is not a technique of absolute evaluation, but a technique for comparatively evaluating alternatives*".

Habitat Evaluation Procedure was developed in the United States to be used in the wetland mitigation banking system to achieve the NNL criteria. HEP measures the exact extent of the off-site compensatory measures using the actual site's information (status of the receptor habitat) where compensatory measures are going to occur.

The application of HEP can be divided into three steps: 1) Estimating the environmental impact that the development project would induce by executing an EIA. If the EIA has not been completed, then HEP can help comparing different scenarios of environmental impacts (Tanaka, 2008). 2) Identifying the "ideal" compensatory/complementary remediation measures, i.e. measures that would adequately compensate the impacts if they were really implemented, and that is the biodiversity offset project. And 3) Evaluating the cost of the compensatory/complementary project following economic methods of monetization (Dumax & Rozan, 2011).

The applicability of HEP gains reliable importance in the calculation of compensation measures of unfamiliar sites to society that will be subject to a LUC, i.e. ecological environments of fundamental importance unknown or poorly known for society. Thus, the premise of HEP is that environmental impacts over unfamiliar sites are more accurately estimated by using ecological information, rather than information collected by stated and/or revealed preferences economic methods.

The published HEP by USFWs in 1980 is a species-habitat approach for impact assessment with the fundamental assumption that habitat quality and quantity can be numerically described and that species can be proxies of habitat quality. Dumax and Rozan (2011) adapted the original HEP by adding one step[14] and converting it into an economic valuation method with ecological data as input. Both the original and the adapted HEP are used to calculate the optimal size of the compensation area based in the predicted impacts over the natural resources/services. It uses ecological data to calculate the area, in Habitat Units[15] (HU) predicted to be lost in consequence of the development project, and compares it with the HU that can be created to compensate such loss by considering hypothetical compensation measures planned to be carried out in a selected candidate area. The last result is therefore, the area (in physical units) needed to compensate the predicted impacts.

[14] The "adapted HEP" of Dumax and Rozan (2011) also uses flora and fauna species rather than only flora as in the original method.

[15] The Habitat Units (HU) resultant of the HEP is equivalent to one credit tradable in the market-based mechanism of Biodiversity Banking.

5.2.2 Habitat Equivalence Analysis

Habitat Equivalence Analysis (HEA) was developed in early 1990's under the National Oceanic and Atmospheric Administration (NOAA) of the United States, as a methodology used to design compensatory restoration measurements in the framework of oils spills following the Oil Pollution Act of 1990. HEA quantifies the natural resources lost within a Natural Resource Damage Assessment (NRDA) and calculates the scale (magnitude) of the offsetting (compensatory and complementary actions) of the services lost. The cost of the resulted restoration project by the application of HEA becomes the measure of the damage (Zafonte & Hampton, 2009).

By the mid-1990s the HEA began to be applied in the USA to more difficult damage cases when for example the baseline was unknown, the harm was not clearly, or it eliminated the habitat features by physical damage (Chapman & LeJeune, 2007). As the use of HEA expanded, cases arose where the damage was better measured in numbers of individuals lost, such as birds or fish, than in habitat units (i.e., area). In such cases, the remediation was scaled to provide equivalent numbers of replacement individuals, on the theory that the replaced individuals would compensate fully for the lost services. This application of resource-to-resource scaling came to be called Resource Equivalency Analysis (REA). The methods of REA are fundamentally the same as for HEA, but the units of quantification differ (eftec-IEEP et. al, 2010).

The application of the HEA consideres three different options for delivering compensation: 1) 'in kind no-trade-off goal', where identical type of the services must be given back by the same natural providers (i.e. species, resources); 2) 'traded in kind goal', in which the services deliver the same functions but are being generated by different providers (i.e. different species or resources, of example water protection coming from forest with different tree species); 3) 'cross habitat goal', when different services are being provided with diverse natural functions and being delivered by different natural providers as long as a ratio is defined between the new services and the lost ones (Dumax & Rozan, 2011)

The HEA scales the magnitude of the compensation measures by using the following formula (NOAA, 2006; Defrancesco et al., 2014):

$$P = J\frac{V_j}{V_p}\frac{\sum_{t=0}^{n}\left[(1+r)^{m-t}\frac{(b^j - x_t^j)}{b^j}\right]+\left[\frac{(b^j - x_{t=n+1}^j)}{b^j}\right]\frac{1}{r}(1+r)^{m-n}}{\sum_{t=1}^{l}\left[(1+r)^{m-t}\frac{(x_t^p - b^p)}{b^j}\right]+\left[\frac{(x_{t=l+1}^p - b^p)}{b^j}\right]\frac{1}{r}(1+r)^{m-l}} \quad \text{(Equation 1)}$$

Where:

J , is the number of units of the impacted area (e.g. ha or acres)

V_j, is the service(s) provided by the impacted area in units of value per year

P, is the number of offsetting units (in the unit of discounted service-area-year)

r, is the social discount rate. This is used to compare the cost and benefits received by the offsetting actions at differents points in time

m, is the year when the offsetting project starts to provide services

n, is the year when the offsetting project reaches the maximum possible level of provided services for the first time

V_p, is the number of units (area) where the offsetting project is providing services per year

b^j, is the services baseline provided by the impacted area

$x_t{}^j$, is a number of services provided per unit of the impacted area at time t

b_p, is the initial level of services delivered by the offsetting site

x_t^p, is the level of services delivered per unit of the offsetting site

l, is the time when the offsetting project provides the maximum level of services in perpetuity.

In the ex-post calculation of the compensatory remedial measures, the HEA is usually the methodology applied (Penn & Tomasi, 2002; Dunford et al, 2004; Tanaka, 2008; Dumax & Rozan, 2011). Nonetheless, the advantages found in this method, criticisms and doubts have arisen regarding the liability to calculate the equivalent size of the compensatory remedial measure for the environmental damage in question (Dunford et al., 2004; Zafonte & Hampton, 2007).

As analyzed by Dunford et al. (2004) HEA has several assumptions that make this method very sensitive and not a robust method to design compensation projects. According to Dunford et al. (2004) the fundamental assumptions of the HEA are: 1) it uses one single metric to measure the ecological services provided by the injured habitat and the restoration habitat, even when the method is applied to habitats with equating services of different type and quality (e.g. bottom sediments Vs. wetland); 2) it fixes the same proportion of monetary value of the habitat services to the habitat services level; 3) it gives constant and permanent monetary value to one unit of habitat service (e.g. one acre of wetland); 4) it gives same value to the injured service and the services created by the scaled compensation project ($V_j/V_P = 1$); 5) it gives a fix discounting rate (r) to the value of the scaled serviced delivered by the compensation, all along the compensation project lifetime; and 6) it sets the same time profile for the recovery of the different environmental services injured at different extents and magnitudes.

Although the Dunford et al. (2004) have recognised the above as HEA's "weak points" because they represent a "deviation to reality" of the compensation project, the HEA application is still widely used to assess the sum of compensations for environmental damage. HEA helps to assess suitable settlements when applied under the following circumstances, as concluded by Dunford et. Al (2004): a) there is just one contaminant or source of injury; b) the injury is relatively short and occurs in a relatively short and medium-term length; c) there is good baseline information for the services of the injured habitat; d) only one service has been affected; e) similar habitat service can be created or enhanced nearby as a compensation; g) there is a relatively short and relatively certain compensatory-restoration period.

The consideration of welfare and heterogeneity of social preferences are more difficult to be included in the HEA. This issue is still a matter of study (Flores &Thacher, 2002; Zafonte & Hampton, 2007; Martin-ortega et al., 2011; Quétier & Lavorel, 2011) and future work is still needed to analyze the level of applicability of value-based methods as choice experiment and benefit transfer to be incorporated in the HEA.

Besides the HEA's limitations to address compensation for environmental damage, it also has limited applicability in the field of biodiversity offsetting. More specifically, HEA has limited application in the task of assessing credits and debits for a market-based mechanism due to the high sensibility of the method related to: 1) a number of habitat services equal to the monetary value of the habitat service, so if the habitat services decrease the value of the habitat also would decrease in the same amount. 2) The oversimplification of using one single metric to assess the injured and compensated habitats, which becomes very important when dealing with complex habitats as coastal habitats. 3) The assumption that the injured services and compensatory services are the same type and quality. 4) The uncertainty in the time needed for the compensation to deliver the expected ES and the assumption that those services will be delivered at their maximum value in perpetuity (NOAA, 2006) These assumptions can become an issue in some cases and increase the uncertainty to the calculated compensation for the injured habitats. For these reasons, the Habitat

Equivalence Procedure (HEP) has been widely applied in the field of biodiversity compensation even though the HEA is a newer methodology.

5.2.2.1 HEP application example: analysis and discussion of limits and opportunities

An infrastructure development project realized in the coastal Adriatic area at the Northeast Italy (2010) has been taken as a case study for applying the HEP. The area selected for the project is considered unfamiliar since it's not directly used by the near inhabitants neither visitors, making the compensation case suitable for the application of the HEP. Furthermore, the present case provides detailed ecological data to be used for calculating the *target*[16] compensation related to the project's impacts, since HEP is a strong ecological data based compensation valuation method. Lastly, the present infrastructure project gives us the opportunity of comparing the HEP outcome with the real compensation measures taken in place, contributing to the study and analysis of HEP's applicability for future works in the field of ex-ante compensations.

In this case-study, it is known that for the infrastructure construction three ecological areas of a total surface of 88456 m^2 were identified after the Evaluation Impact Assessment (EIA). In those zones, 2110 trees of 24 different protected flora species and diverse sizes and ages were cut. Now, to know what is the *target* compensation measure needed to equitably giving back the environmental values we applied the HEP following the further steps: 1) calculation of the baseline condition in Habitat Units, 2) calculation of the future condition and net impact in Habitat Units, 3) identification of losses, target species and compensation goal, 4) selection of a candidate compensation area, 5) calculation of the Habitat Units for future conditions

[16] *Target* outcome means the best compensation measures from HEP accordingly to the input parameters it requires for calculation to be done, but this procedure it is not the only one that can be used for such calculation. Likewise, other methods as the HEA also offer and a methodology to calculate the optimal compensation for a given environmental impacts. Thus, the *target* compensation expresses this is for this method the best compensation measure calculated, but it doesn't mean that over all other methodological possibilities be the only compensation calculated as the best.

without management, 7) selection of management alternatives, 8) calculation of the Habitat Units for future conditions with management actions, 9) assessing the suitable area for the "ideal" compensatory mitigation measures, and finally 10) estimation of the environmental cost.

<u>Baseline condition in Habitat Units</u>

Following the steps of the "adapted HEP" (Dumax and Rozan; 2011), it is necessary at first identify the delineation of the study area and ecological features to select the *evaluation species* (indicator species) that allow estimating the baseline condition of the areas that are expected to have changes in their biological conditions due to the development project.

The three injured areas have different species presence offering similar ecological services with a density expressed in 42 tree per every 200 m^2. Table 5 presents the ecological features of the three areas and the evaluation species we have selected from the data collected (Table 5.), we have followed the Russell et *al.* (1980) method to calculate the Total Habitat Units (THU) of the baseline are 7104.72.

Table 4. Linking ecosystem services, area types, evaluation species and calculation of Baselines Total Habitat Units.

	Area, m^2	**Ecosystem service**	**Evaluation species**	**Area density[1], tree/m^2**	**HSI[2]**	**HU[3]**
1	275		*Quercus ilex* *Vincetoxico*	0.21	0.84	231
2	1309	Flood regulation,	*Populus canadesis* *Populus nigra* *Salix Alba* *Amorpha fruticosa*	0.21	0.84	1099.56

		Nutrient cycling,	*Rubus ulmifolius*			
3	6874	Soil formation, and Aesthetical	*Quercus ilex* *Pinus pinea* *Rubus ulmifolius* *Ligustrum vulgare* *Rubia peregrina* *Asparagus acutifolius*	0.21	0.84	5774.17
TOT	8456					**7104.72**

[1] The tree density of the areas was assumed to be equal to the annex areas reported to have 42 tree every 200 m^2.
[2] Habitat Sustainability Index (HSI) was calculated using the area density divided by the maximum area density following the model of Russell et *al.* (1980). We have assumed the maximum density area to be 0.25 as indicated to be the expected recovery in the damage compensation measures report.
[3] The HU is calculated by the multiplication of the area (in m^2) by the HSI value.

<u>Future condition and net impact in Habitat Units</u>

The estimation of the area future condition area after the occurrence of the predicted impacts was assumed to be equal to the real environmental damage of the areas. This is based on the hypothesis that if a development project was conducted on the site, all the area would be lost. Thus, the resultant affected area in HU is equal to our estimated baseline. Another way to explain that the hypothesis applies to this case is by considering that all the trees would be cut in our hypothetical development project, the resultant density will be nule and whereby also the HSI. In conclusion, the net impact of the net impact is equal to 7104.72 HU.

<u>Identification of losses, target species and compensation goal</u>

In the hypothetical case that all the areas will be lost because of the development project, and considering that the compensation goal is to have back the same level of services (relative replacement objective), the selected *target species*[17] (Table 2) are going to be different from the evaluation species considered selected for the baseline conditions. This is in line with our damage case study, where additional species were used to compensate the losses.

Habitat Units for the future condition without considering management

We have first considered the candidate compensation area to be 4630 m^2, as this was the available zone where the real case study compensation measures were placed. Then, the calculation of the correspondent HU was computed considering the HIS to be different from the lost areas' HSI. In the lost areas, the density was 0.21 tree/m^2, while in the proposed compensation area we have assumed it to be 0.105 (the 50% of the lost area density) due to their degradation conditions. Thus, it is obtained that the candidate area without interventions is equivalent to 1944.60 HU. Such figures indicate that a bigger area would be needed to equivalently compensate the 7104.72 HU of net impact, or that much effort should be done on implementing management activities to increase Habitat Units of the candidate area.

Habitat Units for the future conditions with management

Reforestation is planned to be carried out in the candidate compensation area. As in the lost areas, three different portion of land were individuated to be enhanced for creating habitat ecologically similar in terms of offered quantity of services. Since the reforestation will increase the tree density, our calculations of HU resulted from the "enhanced candidate area" consider 0.25 trees/m^2 for both, the maximum density and the target density at the area. With this information, it was obtained that the candidate

[17] Species identified to be the indicator of the level of gained services equivalent to the losses. This species can be a) identical to the evaluation species- when considering in kind no-trade-off goal of the compensation measurements, 2) different species- whenever an equal replacement objective is selected to have the same services, 3) different species- whenever a relative replacement objective is selected to provide different services as long as a ratio is defined between services (Duxman & Rozan, 2011)

compensation area offers 4630 HU. This is 2685.4 HU more than the candidate zone without the interventions. Table 5 resumes all the ecological information of the subdivided compensation area and the results of its equivalent HU.

Even if a considerable number of HU has been gained after comparing the candidate area with or without management, still the HU of the net impact (7104.72 HU) is greater than the HU calculated (4630 HU) for the "enhanced candidate area" (with the management actions of reforestation). Therefore, there are 2474.72 HU that would not compensate if the candidate compensation area is not enlarged., or another additional complementing area is considered.

Table 5. Linking ecosystem services, area types, evaluation species and calculation of Total Habitat Units of compensation areas future conditions.

	Area, m^2	**Ecosystem service**	**Target species**	**Area density[1], tree/m^2**	**HSI[2]**	**HU[3]**
1	820	Flood regulation, Nutrient cycling, Soil formation and Aesthetical	*Pinus sp.* *Erianthus ravannae* *Schoenus nigricans*	0.25	1	820
2	2310		*Amorpha fruticosa* *Rubus ulmifolius* *Robinia pseudoacacia* *Salix alba* *Salix cinerea*	0.25	1	2310
3	1500		*Amorpha fruticosa* *Rubus ulmifolius* *Salix cinerea* *Salix purpurea* *Phragmites australis*	0.25	1	1500
TOT	4630					**4630**

[1] The tree density of the areas was assumed to be equal to the annex areas reported to have 42 tree every 200 m^2.
[2] Habitat Sustainability Index (HSI) was calculated using the area density divided by the maximum area density following the model of Russell et *al.* (1980). We have assumed the maximum density area to be 0.25 as indicated to be the expected recovery in the damage compensation measures report.
[3] The HU is calculated by the multiplication of the area (in m^2) by the HSI value.

Target compensatory mitigation measures

A candidate compensation area of 4630 m^2 is not sufficient to offer a proper compensation for the net impact on the original habitat of 8456 m^2. Thus, there is the need to know what extension of the area would equitably give the *target* compensation to the net impact. The optimal size of the compensation area (equation 2) is then 8717.48 m^2.

$$\boldsymbol{ZC} = -\boldsymbol{A}\left(\frac{\sum_{i=1}^{n} \boldsymbol{I}_i}{\sum_{i}^{n} \boldsymbol{M}_i}\right) \qquad \text{(Equation 2)}$$

Where:

ZC, optimal size of compensation area (physical units)
A, candidate area size (physical units)
I, habitat unit losses for the evaluation species *i*
M, habitat units gained after the management of the candidate area for all the target species *i*
n, total number of identified species, either target or evaluation species

Environmental cost

Given the optimal size of the compensation area, 8717.48 m^2, the last step of the HEP is the estimation of the environmental cost based on the estimated cost of implementing the management actions that would equitably compensate for the natural resources/services lost (net impact).

The compensation measurements carried out in our coastal damage case study consider the reforestation of 4630 m^2 of similar areas near the damaged zone. The average cost of the reforestation measures per m^2 was calculated in 7.06 Euros; this gives a total compensation cost of 32 687.80 Euros.

Taken the optimal size of compensation area resulted from applying the HEP to our hypothesis of environmental impacts on the same coastal habitat in consequence on an assumed environmental project that would destroy the entire area, we know the compensation area would need to be 8717.48 m^2. To estimate the environmental cost based in the assumption it equals the cost of the *target* compensation measures it is necessary to consider: planning and designing, environmental impact assessment, permits request, construction and/ or execution of the complementary/compensatory measures (including land purchase), monitoring and mid-course corrections (Dumax & Rozan, 2011).

Keeping the same price of reforestation actions as 7.06 Euros/m^2, the cost of the reforestation would be 61 545.41 Euros. Also, considering that the rest of the cost calculated in our case study is given by the cost of planning and design, 8 808.80 Euros; land purchase (50 Euros/m^2) 435 874.00 Euros; permits and security work measurements 35 129.18.00 Euros; taxes (21%) 20 124.53 euros; and mid-course corrections 10 516.78 Euros, the total environmental cost is 571 998.70 Euros.

Per the HEP results for the coastal damage case study, the reforestation of 4630 m^2 of coastal land was not sufficient to compensate for the lost areas. The compensation area of 8717.48 m^2 would then equitably compensate the net impact. Consequently, the scale and cost of the compensation measures differ considerably. By applying the compensation measure obtained from HEP would secure the environmental compensation of the unfamiliar site, since the method is strongly ecology-based. However, several issues of this method are still in debate and need further investigation.

It is worth to mention that the considerable difference between the compensation project scale obtained by HEP and the real compensation of our case study is mainly due to the differences in the methodologies used. The valuation method followed by the Italian local authorities was a hybrid monetary-resource based valuation method developed exclusively for the occurred damage. According to their experience and the

Italian Environmental Impact Assessment Law art. 32 (VIA della L.R. 8 Settembre 1997), the Environmental Regulations (Legge 3 Aprile 2006 No.152) and the Internal Regulations of the Protected Area where the damage occurred, the authorities decided to focus the estimation of the compensation measurements in the amount of money the responsible enterprise had to pay and the possible environmental enhancements it could carry out as compensation.

In conclusion, the application of the Habitat Equivalence Procedure seems to be a promising environmental-ecological-based method to compensate environmental impact of unfamiliar sites where value-to-cost methods (as revealed and stated preferences) may have limited applicability. Additionally, it may help authorities to follow straightforward procedures. On the other hand, more efforts are needed to adequate the methodology when applying it to ex-ante compensation measures of development projects. We agree with Dumax and Rozan (2011) that additional economic methods, more species indicators and better HSI models may make the HEP more suitable to apply for scaling compensatory environmental measures.

5.3 Simplifying the habitat equivalence methods into an offsetting calculation methodology

Today, with the worldwide current application of offsetting, there is not a unique methodology to calculate the debits and credits of an offsetting scheme. For example, Germany uses the eco-scores (Ökopunkte) procedure (Naumann, et al., 2008), the State of Victoria in Australia uses the habitat hectares approach (McCarthy, et al., 2004), while the State of New South Wales uses the BioBanking Assessment Methodology (DECC NSW, 2007), etc.

In this section, some of the different approaches to calculate debits and credits are revised to analyze the differences in the methodologies used in Germany, Australia, and England to scale offsetting projects.

5.3.1 German eco-score approach

The German eco-score approach is based in the so-called 'biotope value' procedure. In this context, biotopo refers to the habitat types defined in each German Federal State's List of Biotopes (*Biotoptypenlisten*)[18]. The eco-score method relies on the biotope types as indicators for complex ecosystem situations to quantify the debits considering the state of the biotope impacted. Thus, biotope quality is evaluated on the basis of validated (scored) biotope lists available for each German Federal State. These lists are state-wide biotope maps and are supplemented with specific guidelines that allow qualifying the biotope status considering biotic and abiotic factors as metrics (Naumann, et al., 2008).

The eco-score approach allocates 'points' to biotopes according to their 'ecological value'(Quétier & Lavorel, 2011). However, the eco-scores are not designed to account for full ecological equivalency since the scores do not take into consideration variations within a biotope, like location and connectivity, or presence variations of some species or ecosystem-ecological status (Quétier & Lavorel, 2011).

In Germany, the HEA is used in offsets compensation for rare habitats or high-value habitats affected by the impacts of development projects. The HEA provides in these cases a more detailed and accurate calculation of debits and credits because it considers more detailed data about the habitat's baseline, services loss and presented a number of species (Naumann, et al., 2008).

5.3.2 Australian habitat hectare approach

The Victorian Department of Natural Resources and Environment in Australia has developed the Habitat Hectares Approach (HHA) as a methodology for assessing the quality of native vegetation (Parkes, et al., 2003; McCarthy, et al., 2004; Quétier &

[18] See the definition at: http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Biotope.html

Lavorel, 2011). This approach claims to be rapid, objective, reliable and reputable to measure the '*naturalness*' of a habitat as an indicator of its quality for a broad range of species of sites with low-quality vegetation. In this manner, different sites with low-quality vegetation types can be compared based on a single metric identified as the '*naturalness*' (McCarthy, et al., 2004).

In reality, the Australian HHA uses a set of indicators that describe the site condition (as the species composition, potential to provide a habitat for species through time, invasive species, etc.) and its landscape context. These indicators are weighted and combined into a habitat score. Then the habitat score multiplies the site area resulting in a habitat unit that can be used to compare debits and credits. Also, the HHA uses reference areas of 'natural' and 'undisturbed' condition of the same ecosystem type, called *'benchmarks'*, for evaluating biodiversity losses and gains. The HHA focuses on comparing the habitat status and species presence of the benchmark against the impacted site or the offsetting receptor site. When the benchmark is a better condition that the studied site, there has been an environmental loss in the site under study, and when this latter is in a better ecological condition compared with the reference site, there has been an environmental gain. In this way, benchmarks help to assess environmental losses and gains due to their specificity to each vegetation type in each biogeographic region (Parkes, et al., 2003).

As all assessing methods, the HHA also has some weaknesses related to the measurement of the habitat attributes because of their comparison with a single benchmark. The uncertainty about the management contexts in which the method can be used, limit the method robustness to assess the losses and gains (McCarthy, et al., 2004). In this sense, HHA can be complemented using a sort of index of conservation significance (at a regional level) to generate a Biodiversity Benefits Index (BBI). The regional conservation significance is one way to define the area within which offsets must be implemented, together with considerations relating to i.e. species' mobility or ecosystem services' receptivity (Quétier & Lavorel, 2011).

5.3.3 English habitat hectare approach

In 2012 the Department for Environment, Food and Rural Affairs in partnership with the UK's government's advisor for natural environment, Natural England, started a pilot scheme for biodiversity offsetting. Six sites were chosen to implement conservation measures that deliver biodiversity benefits in order to pilot the applicability of habitat equivalency methodology that sustains an offsetting scheme.

The methodology applied in the piloting areas follow the methodology developed by DEFRA (2012) that is presented in detail in this section.

5.3.3.1 Calculation of the debits and credits

Similarly to the Habitat Hectare Approach, DEFRA's methodology calculates the debits and credits of the impacts and offsets, by weighting the two features of the habitat under study referred as habitat's 'distinctiveness' and 'condition'. The distinctiveness refers to the habitat's species richness, diversity, rarity (at local, regional, national and international scales) and the degree to which a habitat supports species rarely found in other habitats (DEFRA, 2011b). The designation of the habitat distinctiveness level is given by considering the UK Biological Action Plan and the Annex 1 of habitat categories, EU Habitat Directive, and the 'technotope' of Kyläkorpi et al. (2005). On the other side, the condition relates to the site's management plan, which in the UK is given by the Biological Action Plan and the Handbook of Higher Level Agri-environmental scheme for farms Environmental Plan (DEFRA, 2011b).

The combination of the distinctiveness and the habitat condition results in an offsetting metric identified as 'habitat hectares unit' (Table 6) that identifies a determined area of equal ecological type established by the type of habitat, species presence and habitat condition. If a large area of land has different types of condition or distinctiveness, it should be divided considering the proportion of that area that shares same habitat type and ecological condition, specifically same distinctiveness and condition, to set one single value of 'habitat hectares unit' per each of the subdivisions found.

The offset metric can be used straightforward to assess the impact on biodiversity at a development site, i.e. the debits of the total area of habitats lost by multiplying the 'habitat hectare unit' of the site by the number of hectares identified with the distinctiveness and condition that resulted in that habitat hectare unit. While, when used to assess the credits of a site that will deliver ES as a biodiversity offset, a two-stage approach is applied. Firstly, the current status of the offset receptor area is calculated in habitat hectares before any enhancement, creation or other type of management measures occur. Then, the credits are calculated in habitat hectares when the receptor site has been managed, and its ecological condition has improved. The value of the generated credits is the difference between the baseline biodiversity value of the site and its value after enhancement (Pearce, 2013).

Note that this habitat hectare metric is based on habitats total biodiversity and condition. Therefore the credits calculation do not appropriately reflects any specific species status. Instead, the assessment for each hectare of habitat represents a proxy for the value of all the biodiversity it contains or which it may support. However, for individual species, other resource-based methods can be used or developed to incorporate the status of a particular species alongside offset when necessary (Pearce, 2013). Also, is worth mentioning that according to DEFRA (2012) the use of this metric is not suitable for calculating debits and credits of hedges, since their value is better described using linear units.

Table 6. Metric used in the DEFRA offsetting pilot to calculate biodiversity offset values per hectare of habitat (DEFRA, 2012).

	Habitat distinctiveness

		Low (score = 2)	Medium (score = 4)	High (score = 6)
Condition	Good (score = 3)	6	12	18
	Moderate (score = 2)	4	8	12
	Poor (Score = 1)	2	4	6

5.3.3.2 Application of multipliers

In addition to the basic DEFRA's metric, a series of multipliers is used to consider the risk factors associated with delivering an offset. As the criterion 4-3 of the BBOP Standard on Biodiversity Offsets indicates (BBOP, 2012), the consideration of risks are of great importance in delivering offsets. Multipliers can incorporate the risk(s) associated with the following factors on offsetting:

Delivery risk: Risk of not being able to restore or create a particular habitat type successfully. Improving the condition of habitats that are already of high distinctiveness (defined as 'habitat restoration' in the offsetting pilot) is more straightforward than trying to re-create habitats from the land of low distinctiveness (defined as 'habitat creation' in the offsetting pilot). Table 7. Delivery Risk multiplier for accounting the difficulty of restoration or creation of a habitat illustrates this risk multipliers used for the DEFRA's pilot projects. Additionally, DEFRA's guidance (DEFRA, 2012) provides an indication of the timescales and restoring feasibility for some ecosystems types in Europe to give an indication of the type of risk that can be associated with a wider type of ecosystems depending on their practicality of been restored or created.

The spatial risk is associated with the choice of location of the offset (Table 8). It addresses the fact that biodiversity offsetting is likely to be most effective when it is in line with established strategies for biodiversity enhancement within a particular territory. To account for proposals in which a potential offset site does not contribute to such strategies a multiplier is added to the calculation of credits. This multiplier has the effect of steering schemes towards sites that best meet the needs of local strategies. Thus it is governed by policies established in England by local authorities for the prioritization of receptor sites.

The temporal risk is associated with the length of time required to create or restore habitat (Table 9). It addresses the fact that, where compensatory offsets are initiated at the same time or after development activity, there will be a period in which overall biodiversity is lost. In such situations, the impacts of the development will only be fully compensated once the offset project has reached its agreed target. Thus the effect of this multiplier is to increase the area of compensation required in line with the number of years needed to achieve the objectives of the compensation offset scheme.

It is worth to bear in mind these multipliers are applied to all compensation measures of environmental damage, and to offsets that occur contemporaneously or after the development project, i.e. all measures delivering the benefits after the impacts, i.e. post-impact compensatory and complementary remediation measures. These multipliers are not applicable to calculate the compensation credits in Biodiversity Banking. This, encourages the provision of offsets where the credits are delivered ex-ante the impacts and therefore, are likely to have a significantly greater value regarding offset credits per hectare, than a similar area of land that is proposed for future offsetting.

The risk multipliers are applied to the value of offsets credits calculated for receptor sites of the offsetting. Although referred to as multipliers, mathematically they can be used in two ways: 1) as multipliers, to increase the total area of land required to deliver a set number of credits or, 2) as dividers, to reduce a number of offset credits that a set area of land can deliver (Pearce, 2013).

Table 7. Delivery Risk multiplier for accounting the difficulty of restoration or creation of a habitat (DEFRA, 2012).

Difficulty of restoration/creation	Multiplier
Very High	10
High	3
Medium	1.5
Low	1

Table 8. Spatial risks multiplier associated with the choice of location of the offset (DEFRA, 2012).

Local parameters	Multiplier
Offset is in a location identified by the government as a strategic reception area	No multiplier applied
Offset is buffering, linking, restoring or expanding a habitat outside an area identified in any official offsetting strategy	2
Offset is not making a contribution to any official offsetting strategy	3

Table 9. The temporal risk associated with the length of time required to create or restore habitat (DEFRA, 2012).

Years to target condition	Multiplier
5	1.2
10	1.5
15	1.7
20	2
25	2.4
30	2.8
32	3

CHAPTER

SIX

DEVELOPING A BIODIVERSITY OFFSETTING METRIC FOR ITALY

This chapter proposes a metrics tailored for the case of Italy and exercises its practical application in the case study of the high-speed railway *Pedemontana Veneta* of Northern Italy.

The proposed metrics considers the condition and area of the impacted environment through proxy measures falling into the definition of *aggregated and indirect-multiple attributes* (as seen in Chapter 4) and are based on the Habitat Hectare Approach (HHA). The HHA was originally developed in Victoria Australia in 2002 and ever since used internationally by the Business and Biodiversity Offsets Programme (BBOP). More recently, in 2012, the HHA adapted by the UK Department for Environment, Food and Rural Affairs (DEFRA) to give the basis for the English Biodiversity Offsetting Scheme (Platinum, 2009; Treweek, J., et. al., 2009; DEFRA, 2012).

The HHA assess the impacts by quantifying the value of habitats considering three criteria (DEFRA, 2012):

1. **Distinctiveness** refers to the importance or rarity of the habitat concerned at local, regional, national and international scale. The distinctiveness is assessed as low, medium, high depending on its capacity to support flora and fauna important species.

   The distinctiveness of a habitat include parameters such as species richness, diversity, rarity (at local, regional, national and international scales) and the degree to which a habitat supports species rarely found in other habitats. (DEFRA, 2012). The designation of the habitat distinctiveness level is given by considering the habitat type/biotope and priority according to the EU Habitat Directive and national importance expressed by the Italian Institute for Environmental Protection and Research, ISPRA (*Istituto Superiore per la Protezione e la Ricerca Ambientale*).

2. **Condition** refers to the quality of the impacted environment. It can be identified as poor, moderate or good based on an assessment considering the local standard framework.

The condition can also be thought as to the habitat capacity to provide a suitable environment to support the species survival. The area's management plan is a good indicator of the area's condition. In the UK the Biological Action Plan divides the habitat condition into three categories according to the Handbook of Higher Level Agri-environmental scheme for farms environmental plan (DEFRA, 2011b). In Italy, the condition is given by the Habitat Conservation Degree in the case of Annex 1 habitats of the Habitat Directive, and by the management plan for other areas.

3. **Area** of the impacted environment in hectares.

Altogether, the three habitat proxies, distinctiveness, condition and area, allow assessing the magnitude of the impacts occurred in the developed site in habitat units, or as it can also be expressed in *habitat debits*.

In addition to these three elements, the quantification of the habitat units provided by a potential land for compensation incorporate the use of multipliers that allow considering the risk linked to an off-site compensation as presented in Chapter 5. Such risks are: (BBOP, 2012; DEFRA, 2012): 1) delivery risk associated with the risk of not being able to restore or create a particular habitat type successfully. 2) The spatial risk associated with the choice of location of the offset. In the case of Italy, such areas are primarily given by the European Habitat Directive (92/43/EEC) and supported, by the Italian Institute for Environmental Protection and Research, ISPRA (*Istituto Superiore per la Protezione e la Ricerca Ambientale*) with the declared critical national habitats (ISPRA, 2014). And 3) temporal risk associated with the time required to create or restore habitat.

To measure the area, condition and distinctiveness previous to the development (pre-operam state), ecological information such as land use, habitat type, species presence and relevant related data given by the Environmental Impact Assessment (EIA) and the Ecological Impact Assessment (EcIA) set the ecological baseline. In like manner, the information of the potential offsetting area should be available to contrast the deliverable habitat credits with the habitat debits of the development project. Therefore, this information is processed resulting in habitat credits and debits necessary to scale up a proper offset.

6.1 Italian factors to consider

Italy hosts a large proportion of the species that are threatened at European level, and as an EU Member State the country has committed to halt the biodiversity loss by 2020 according to the Biodiversity Strategy 2020. Considerable conservation efforts are needed to ensure that the status of the Italian species improves in the long term. In this direction, the present metric proposal aims to contribute to developing suitable methods for biodiversity conservation in Italy. The objective of is to create a proxy to assess the environmental impacts of Italian habitats not addressed by neither the European Habitat and Wild Birds Directives, nor the EIA Directive.

The proposed metric is based on the HHA and its most recent application into the English biodiversity offsetting metric (DEFRA, 2012), with the particularity that it introduces three elements considered essential for the biodiversity offsetting applicability in the Italian territory: 1) proximity to the impacted site, 2) landscape contribution, and environmental services delivered.

The development of the metric here proposed considers a series of principles[19] important for the metrics target, goal and transparency. Such principles have been established by the internationally recognized standards of BBOP which are here described:

1. **No net loss.** The offset must contribute to the not net loss of the biodiversity in Italy and seek preferably a net gain of the biodiversity values affected because of development.

[19] Principles based on the BBOP principles for Biodiversity Offsets http://bbop.forest-trends.org/documents/files/bbop_principles.pdf

2. **Mitigation hierarchy.** The offset must be applicable after the mitigation hierarchy committed to avoiding, minimize and compensate the development's projects impacts on-site.

3. **Limit to what can be offset.** The offset should be feasible and realistic compensating for biodiversity values able to be targeted, assessed and monitored. Some values of biodiversity can never be adequately compensated, such as in endangered species and habitats, and therefore are not appropriate for offsetting.

4. **Additional to existing schemes.** The offset should be additional to the already planned or implemented activities to conserve biodiversity and should enhance the management of local habitats.

5. **Consistent with legislation.** The offset must not obstruct the in force legislation of environmental impacts liability and should not overlap with it.

6. **Clear and understandable.** The offset should establish a simple and clear tool to be implemented easily by developers, local authorities, and others.

7. **Transparent and inclusive of traditional knowledge.** The offset should allow the stakeholder participation and consider the traditional knowledge for its implementation.

8. **Landscape-scale and long-term outcomes.** The offset should consider the landscape context and seek long-term outcomes by planning the management approach to be implemented, maintained and evaluated at least for the project's impacts, and preferably in perpetuity to compensate for the occurred land-use change (i.e. consumed land).

The metric consists of the following steps sequence to assess the total habitat debits at first:

1. Identify the land transformed due to the development project;

2. Map the consumed land and divided it into its habitat types identified by the CORINE habitat biotope (ISPRA biotopes equivalence table Annex 1 of this thesis) and indicate its area in hectares;

3. Assess the habitat distinctiveness value according to the habitat type. It is important to mention that the development projects falling into Natura 2000 sites (i.e. the Annex 1 of the EU Habitats Directive[20]) undergo mandatory compensation revised by the local authority and required on case-by-case basis. Accordingly, these habitats are not accounted in the total habitat debits unless the EIA and EcIA mention non-significant impacts or temporary impacts over those areas that won't be addresses by the mandatory compensation.;

4. Assign the habitat condition value according the habitat management, if any, or ecological indicators surveyed onsite;

5. Calculate the habitat debits for each type of habitat by multiplying the habitat distinctiveness value, its condition value and its area in hectares;

6. Assess the total habitat debits by summing up the debits of all habitat types impacted;

7. Assess the habitat credits the development project is considering to create on-site, if any, by considering the foreseen habitat restoration o recreation included into the development project;

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1. [20] For more details http://www.minambiente.it/sites/default/files/archivio/allegati/rete_natura_2000/misure_compensazione_direttiva_habitat.pdf (available in Italian).

8. Quantify the net debits by substracting the credits of the development project from the total debits. The net debits are the total impact needing compensation.

6.1.1 Habitat distinctiveness

This metrics proposal bases on the habitat distictiveness, condition and area of the impacted site. Then, to recognize the different habitats that underwent land transformation, the development site need to be mapped, divided into the different habitat types according to their biotope (Annex 1) and assign to each habitat type their distinctiveness value following the Table 1.

There are some very valuable habitats classified as *critical habitats* (Table 10) which situation and modification are addressed by the Habitats (Art 6 [3] and [4]) and Wild Birds Directive (92/43/EEC and 79/109/EEC, respectively) and by the Annex B of the D.P.R. on Environmental Impact Assessment (Decree of the President of the Republic) published on April 12 1996 (after the first version came into force in 1985). These areas are proprietary and protected by the European Union, and so, bespoke compensation is required and followed up by the Italian Government.

The EcIA and EIA of projects traversing or modifying Natura 2000 habitats give the information necessary of the compensation that the developer will carry out as part of the project. Often nonsignificant impacts and interim losses are identified in these official documents, which can be of use to design the offet for the unaviodable impacts, and that in fact are considered in this metrics proposal (see section 6.2, metrics proposal application to the Pedemonatana Veneta case-study). This metric proposal provides valuable guidance to assess, in advance the impacts, the equitable compensation measures to compensate for impacts on Natura 2000 sites.

According to the distinctiveness of the impacted habitat in question, the offset must comply with a suitable compensation goal to give back to nature what has been impacted. For example, all habitats of high distinctiveness (natural and seminatural habitats) enlisted in Annex 1 of this thesis, may need a like for like offset as the first option or, in justified cases, a trade in kind offset when the overall result delivers better results.

The value of the habitats distinctiveness is based on the logic followed by DEFRA Methodology for Biodiversity Offsetting and the scientific research that supports this methodology (DEFRA, 2012; DEFRA, 2011; Treweek, 2010; Temple et al., 2010).

According to BBOP, the definition of the habitat classification can be understoon as (Table 10):

- **Critical habitat**: Areas with high biodiversity value, including:

  (i) Habitat of significant importance to critically endangered and endangered species;
  (ii) Habitat of significant importance to endemic and restricted-range species;
  (iii) Habitat supporting globally significant concentrations of migratory species and congregation species;
  (iv) Highly threatened and unique ecosystems; and/or
  (v) Areas associated with key evolutionary processes.' (BBOP, 2012)

- **Natural and seminatural habitats:** 'Areas composed of viable assemblages of plant and animal species of largely native origin, and/or where human activity has not essentially modified the area primary ecological functions and species composition.' (BBOP, 2012).

- **Modified habitats:** 'Areas that may contain a large proportion of non-native plant and animal species, and/or where human activity have substantially modified the area's primary ecological functions and species composition. It may include areas managed for agriculture, high nature value farmlands, forest plantations, reclaimed coastal zones and reclaimed wetlands'. (BBOP, 2012). Also including areas with landscape beauty value as mosaic landscapes with forest elements, vineyards, olives plantations and other fruits plantations.

- **Heavily modified habitats:** Areas with non-native plant and/or animal species where human activity have severely modified the ecological functions, such as intensively managed areas for intensive agriculture, modified rivers and streams, mine remnants, hedges, recreational parks and artificial lakes and grasslands of large dimension that provide the society with recreational, environmental services as well as the historical building as historical walls, castles, and villas.

- **Artificial habitats:** are all urbanized and industrialized habitats covered with merely asphalt flooring.

Defining of the offsetting goals (Dumax & Rozan, 2011; DEFRA, 2012):

- **Bespoke compensation** is a customized compensation that the local authority requires the developer in order to gran the construction permit, in case the project falls into Natura 200 habitats and woodlands. The development on these habitats would be unlikely, but in case a local planning authority granted a permit on this habitat type, any compensation would have to be bespoke, preferably on-site, and managed on a case by case basis. It is the responsibility of the local planning authority to decide if the offsetting mechanism can be used.
- **Like for like:** in kind, no-trade-off goal, identical type of the services must be given back by the same natural providers (i.e. species, resources).

- **Traded in kind:** the services lost are compensated by the same services provided by different species or resources, as long as the habitat credits are equitable. For example, water protection coming from forest with different tree species.

- **Trade up:** cross-habitat goal, when different services are being provided by diverse natural functions and delivered by different natural providers, as long as an equivalence is defined between the new services and the lost ones in terms of habitat credits. Offsite-compensation is encouraged with higher distinctiveness habitats.

Table 10. Habitat type, distinctiveness and biodiversity offseting type.

Distinctiveness (value)	Habitat classification	Offsetting goal	Notes
Very high (4)	Critical habitats	Bespoke compensation required by the local authority following the EIA, Habitat and Birds Directive Interim losses and non-significant impacts[21] of the EIA and EcIA can be addressed by the offsetting with trade in kind goal besides the bespoke compensation required by the Habitat and Birds Directive	Habitats included in the Annex 1 of the EU Habitat Directive[22]
High (3)	Natural and seminatural habitats	Like for like	Rest of habitats not included in the Annex 1 of the Habitats Directive, but included in the list of Habitats of National Interest (ISPRA, 2014) and the rest of natural and semi-natural habitats of Italy. See Annex 1, distinctiveness values for all Italian habitat types

[21] The designation of non-significant impacts must follow the significate criteria of the EIA Guidelines published by the Italian Ministry for the Environment and Land (2001) available at http://www.isprambiente.gov.it/it/temi/valutazione-di-impatto-ambientale-via

[22] The Ramsar sites are included in the protected habitats of the Habitats Directive, and hence, incorporated into the Natura 2000 sites and their correspondent habitat type.

Medium (2)	Modified habitats	Trade in kind	Habitats in Annex 1
Low (1)	Heavily modified habitats	Trade up	Habitats in Annex 1
Very Low (0)	Artificial habitats	Not applicable	Habitats in Annex 1

6.1.2 Habitat condition

Besides the habitat distinctiveness of the impacted sites it is important to know the condition of such habitat, i.e. its capacity to provide the suitable environment to support the species survival. The condition assessment has not standardized procedures and relies on experts' opinion of the impacted site. DEFRA's offsetting methodology uses the area management plan as an indicator of the area condition and divides it into three categories according to the handbook of Higher Level Agri-environmental scheme.

Usually, the management plan gives a good level of information about the site condition as it normally includes detailed information about the species presence, distribution, and abundance. Nonetheless, not all impacted sites will have a management plan, and in such cases, it would be necessary to have a standard guideline to determine the area's condition and be used in this metrics. The Annex 2B of the Italian Guidelines for the EIA execution (ISPRA, 2001) gives a list of sensible sites in terrestrial and marine environments that need a detailed valuation of the condition. For these environments and the rest of the Italian CORINE biotopes types an assessment of the flora and fauna species presence must be carried out as well as an evaluation of other environmental area functions (as water purification and provision, food provision, soil erosion protection, etc.) to assess the site condition.

The flora and fauna species condition can be assessed using the ecological surveys of the ISPRA manual "*Gli habitat in Carta della Natura*" (Angelini et al., 2013). This give a detailed description of the species representing diverse habitat types (identified with the EUNIS code, equivalent the CORINE Biotope[23]) for proprietary, non-proprietary sites, whether Natura 2000 sites or not. For the Natura 2000 sites the Italian Interpretation Manual of the habitats (92/43/EEC Directive) (Biondi et al., 2010) gives a straight forward guideline to assess the characteristic element's condition of priority habitats. On the other hand, the consideration of ecological functions of the habitat in question is open to the expert site interpretation.

After the on-site application of the survey to the site in question, the condition can be identified as good, moderate or poor. In certain cases, the on-site assignation of the site's condition can be replaced by the analysis of the recent (realized within five years time frame) management plan if any.

6.1.3 Offsetting factor

The integration of the habitat distinctiveness and condition, whether for the impacted or offset site, gives results in the value of the offsetting factor (Table 11) used to account for the habitat debits and credits.

Table 11. Offsetting factor values resulted from the combination of habitat's distinctiveness and condition.

		Habitat distinctiveness			
		Low (score = 1)	**Medium (score = 2)**	**High (score = 3)**	**Very high (score = 4)**
Condition	**Good (score = 3)**	3	6	9	12
	Moderate (score = 2)	2	4	6	8
	Poor (Score = 1)	1	2	3	4

[23] Equivalences table of EUNIS, CORINE and Habitat Directive codes available at http://www.isprambiente.gov.it/it/temi/biodiversita/lispra-e-la-biodiversita/attivita-e-progetti/elenchi-degli-habitat-italiani

The habitat units (debits for the impacts and credits for the offsets) is then obtained as follows:

Habitat unit = Offsetting Factor (OF) * Area (ha) (Equation 3)

6.1.4 Designing the offsetting project

Following the calculation of the habitat debits of the impacted site two different manners of scaling-up the compensation project exist:

A. Using the debits.

The design of the offset project can be done by converting the debits into the area that will be required to offset the habitat debits. The offsetting area will then provide compensation suitable for the set offsetting goal according to the distinctiveness of the habitat lost. This scaling-up procedure can be used as an exploratory measure to know the offsetting cost and the area needed to compensate for a development project.

B. Using the available compensation receptor site.

From the practical point of view, the compensation of a development project is scaled-up after the receptor site is identified. In this case, the goal of the offsetting can tackle specific conservation priorities and help to develop environmental compensation policies towards specific needs at local scale. The receptor site can be selected by the developer in voluntary basis or be suggested by the local authorities.

The credits are assessed using the same metrics and procedure to evaluate the condition and distinctiveness of the site, as follows:

The metrics consider the following steps for scaling-up the offsetting:

1. Identify the receptor site according to the offsetting goal;

2. Map the receptor site and divided it into its habitat types identified by the CORINE habitat biotope (ISPRA biotopes equivalence table Annex 1 on this thesis) and indicated its area in hectares;

3. Assign the habitat distinctiveness value according to the habitat type[24];

4. Assign the habitat condition value according to the habitat management, if any, or ecological indicators surveyed on-site;

5. Identify and assign the risks multipliers according to the creation[25]/restoration[26] of the offsetting site;

6. Calculate the habitat credits for each type of habitat by multiplying the habitat distinctiveness value, its condition value and its area in hectares;

7. Sum of the habitat credits of all habitat types;

6.1.5 Consideration of risk multipliers

As described previosly, the quantification of the habitat credits provided by the offsetting receptor site shall consider the risk multipliers. In this metrics proposal, the delivery and temporal risk multipliers agreed on the same values as the DEFRA Offsetting Methodology, 2012 and are detailed in Annex 2 of this thesis and 3. For the spatial risk multiplier this metrics proposes the following parameters:

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[24] Notice that development projects falling into Natura 2000 sites (i.e. the Annex 1 of the EU Habitats Directive) undergo mandatory compensation revised by the local authority and required on case-by-case basis. Accordingly, these habitats are not accounted in the total habitat debits unless the EIA and EcIA mentions non-significant impacts or temporary impacts over those areas that won't be addresses by the mandatory compensation. For more details http://www.minambiente.it/sites/default/files/archivio/allegati/rete_natura_2000/misure_compensazione_direttiva_habitat.pdf (available in Italian)

[25] Establish priority habitat on land where it is not present and where no significant relicts of the currently exist (DEFRA, 2012)

[26] Improve the condition of an existing habitat (DEFRA, 2012)

- Multiplier = 1. The offset receptor site is buffering, linking or enlarging an Italian priority habitats[27] in the same geographical region where the impacts occurred.

- Multipliers = 2. The offset receptor site is buffering, linking or enlarging Italian priority habitats in a different region where the impacts occurred.

- Multiplier = 3. The offset receptor site is not contributing to buffering, linking or enlarging Italian priority habitats.

6.2 Metrics proposal application: The case of the Pedemontana Veneta highway in Veneto

6.2.1 The project of Pedemontana Veneta highway

The "*Superstrada Pedemontana Veneta*" is a 94,577.57 km long toll highway proposed by the Veneto Region to enlarge the national highways network into the European Corridor no. 5 of the Trans-European Transport Network project of the European Commission[28]. The SPV (*Superstrada Pedemontana Veneta*, named SPV hereafter) aims to improve the quality and security levels of the development and mobility needs of the most industrialized area of the northeast region of Italy and contribute to the projected European corridors network.

The SPV seeks to alleviate the busy area of the Vicenza and Treviso communities, and in particular the *Valle dell'Agno, Montecchio Maggiore e Castelgomberto*, and the piedmont zone in Veneto extending between *Malo and Bassano del Grappa* in the Vicenza Providence and *S. Zenone degli Ezzeini*, *Montebelluna e Spresiano in Bassano del Grappa* in Treviso Providence. In total, the SPV project intersects 36 communities of these two providences, 22 in Vicenza and 14 in Treviso (Table 12).

[27] Natura 2000 areas, SSSI, SPA or SAC
[28] http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/site/en/maps.html

Table 12. Communities intersected by the SPV in Vicenza and Treviso.

Vicenza Providence	Treviso Providence
1. Brendola	1. Loria
2. Montecchio Maggiore	2. San Zenone degli Ezzelini
3. Trissino	3. Riese Pio X
4. Castelgomberto	4. Altivole
5. Brogliano	5. Vedelago
6. Cornedo Vicentino	6. Castelfranco Veneto
7. Malo Vicentino	7. Montebelluna
8. Isola Vicentina	8. Castello di Godego
9. Villaverla	9. Trevignano
10. Thiene	10. Volpago del Montello
11. Sarcedo	11. Giavera del Montello
12. Montecchio Precalcino	12. Povegliano
13. Breganze	13. Villorba
14. Mason Vicentino	14. Spresiano
15. Pianezze	
16. Marostica	
17. Nove	
18. Bassano del Grappa	
19. Rosà	
20. Cassola	
21. Mussolente	
22. Romano d'Ezzelino	

The project will be divide into 26.50 km of elevated road, 51 km of the trench, 9.50 km in the artificial tunnel and 7.50 km in the natural tunnel. In total, there will be 35 tunnels, 33 artificial and two natural. Figure 3 shows the SPV's geographical location in Italy, and figure 4 shows the technical division sections the projects was divided into for its construction.

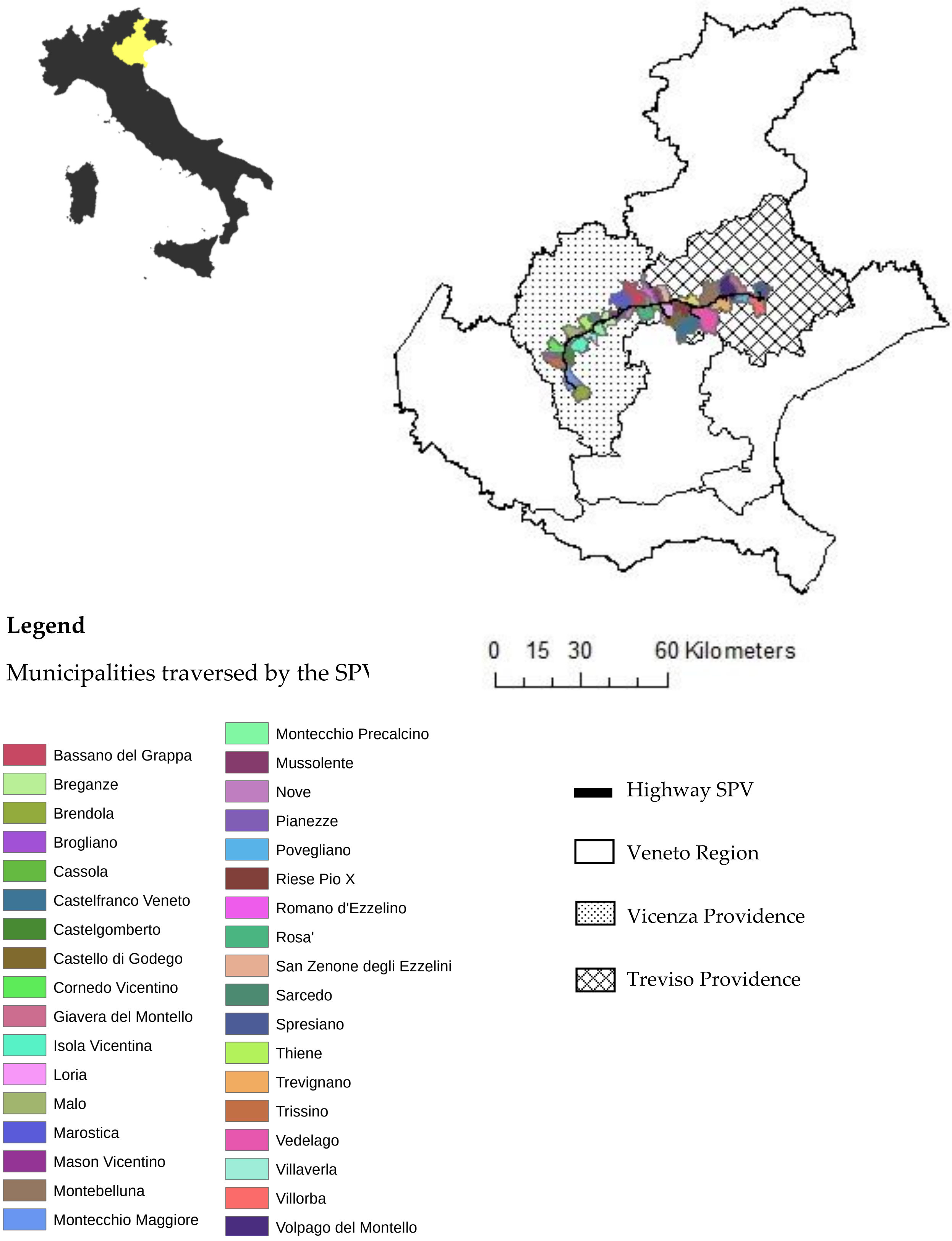


Figure 3. SPV location into the Veneto Region of Italy.

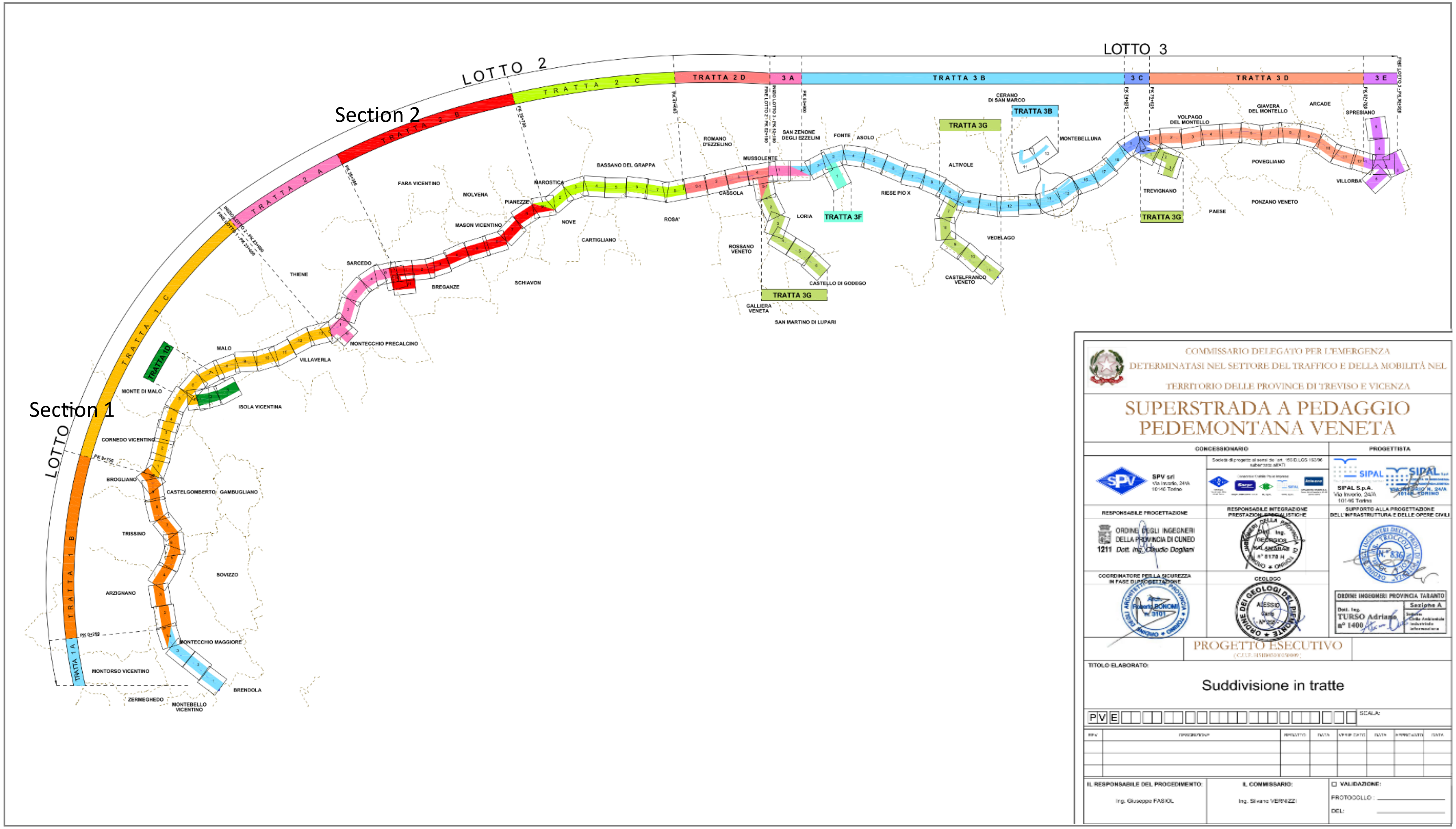


Figure 4. SPV project sections subdivisions.

6.2.2 Ecological Impact Assessment

The Ecological Impact Assessment (EcIA) of the SPV (elaborated by PROTECO) follows the "Methodological guidance on the provisions of Article 6 (3) and (4) of the Habitats Directive 92/43/EEC" (European Commission, 2001) and the Dgr 3173/2006 of the Italian Veneto Region "Methodological guide for the EcIA". Furthermore, it provides detailed information related to the ecology of the development site, as required by the Article 5 of the Environmental Impact Assessment Directive and its Annex IV (Drayson & Thompson, 2012).

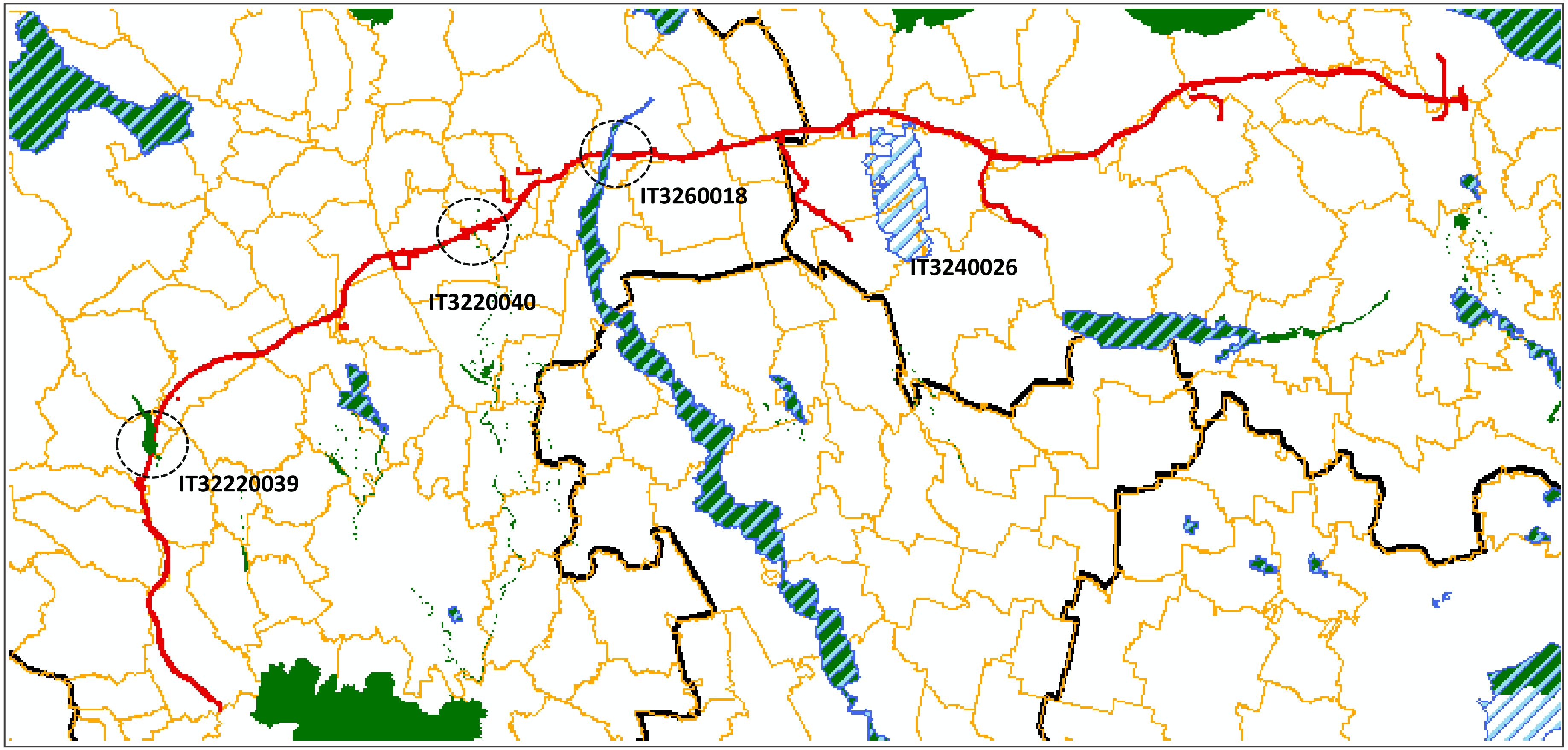
There were elaborated two EcIA of the SPV project, one in 2005 and a more recent version in 2012, because of the modification made in the project to decrease the impact mainly over Natura 2000 sites and the enforcement of the Dgr 3173/2006 "Methodological guide for the EcIA". The most recent EcIA depends on in the analysis of the ecological impacts and gives detailed information about the impacts of the following direct and indirect impacted Sites of Communal Interest (Figure 5):

i. SSSI IT3220039 "*Le Poscole*" intersected by the section 1, subsection 1C

ii. SSSI IT3220040- "*Bosco di due Vile risorgive limitrofe*" intersected by the section 2, subsection 2B

iii. SSSI and SPA IT3260018 "*Grave e zone umide del Brenta*" intersected by the section 2, subsection 2C

iv. SPA IT3240026 "*Prai Castello di Godego*" not directly intersected but neighboring the highway with 130 m distance



Legend:

IT3220039 "*Le Poscole*", IT3220040- "*Bosco di due Vile risorgive limitrofe*", IT3260018 "*Grave e zone umide del Brenta*", IT3240026 "*Prai Castello di Godego*"

SPV   Intersected sites   SSSI   SPA   Providences   Municipalities

Figure 5. Natura 2000 sites directly impacted by the SVP.

There are another eleven Natura 2000 sites neighboring the SPV that go from 0.13 km to 7.85 km distance of vicinity to the road (Table 13). However, the only site considered into the EcIA is the ZCI IT3240026 "*Prai Castello di Godego*" because it short distance to the highways (only 0.13 km away).

Table 13. Natura 2000 sites neighboring the "*Superstrada a pedaggio Pedemontana Veneta*".

Natura 2000 Code	Type	Name	Distance (km)
IT3220037	SSSI	*Colli Berici*	1.50
IT3220038	SSSI	*Torrente Valdiezza*	3.70
IT3220008	SSSI	*Buso della rana*	5.50
IT3220013	SPA	*Bosco di Dueville*	2.75
IT3240004	SSSI	*Montello*	2.36
IT3240028	SSSI	*Fiume Sile dalle sorgenti e Treviso ovest*	7.85
IT3240011	SPA	*Sile_ sorgenti, paludi di Morgano e S. Cristina*	7.85
IT3240012	SSSI and SPA	*Fontane Bianche di Lancenigo*	4.00
IT3240030	SPA	*Grave del Piave- fiume Soligo- Fosso di Negrisia*	3.40
IT3240023	SPA	*Grave del Piave*	3.40
IT3240026	SPA	*Prai Castello di Godego*	0.13

6.2.2.1 Predicted adverse impacts

The EcIA sets the physical area limiting the impacts that the project will have over the environment by considering the following elements (PROTECO, 2012):

- the nature and dimension of the project and possible effects
- the project's data and information disponibility
- the project dimension, the effects over the interested area due to past, present or future activity linked to the project

- the landscape features and relevant ecological boarders

According to this, the impacts were identified as permanent and temporary. The permanent impacts are due to the change of land use, habitats extension reduction, and greenhouse gases, noise and vibrations emission from the road in use. On the other hand, the temporary effects relate to the construction phase and are the sediments movement, the pollutant gasses from the construction equipment, the particles suspended due to the transport of material and construction, and the temporary occupation of the environment as construction site (PROTECO, 2012).

According to some scientific studies cited in the EcIA, it is stated that during the construction and operative phases the noise emissions become a real disturbance to the fauna if it exceeds 50 dB (PROTECO, 2012). The results obtained from an experiment carried out by the EcIA support that the noise values are bellow 50dB when the distance to the highway is at least 400 m. So that, the EcIA considers the highway longitude and width plus 500 m of buffer surrounding all the development, to identify the temporary and permanent alteration factors and evaluate the significance/insignificance of direct and indirect impacts.

The EcIA concludes there are not significant permanent impacts over none of the four Natura 2000 sites of interest, but one interim loss over the communal interest habitat 6510 of the SCI IT3220039 "*Le Poscole*". In the section 1, subsection 1C, the project considers the construction of a natural tunnel implementing the jet-grouting technic that will temporary alter 6,000 m^2 of the habitat 6510. The restoration of this temporary habitat loss and fragmentation at the SSSI Natura 2000 site "*Le Poscole*" will become after the construction phase finished trying to recover the site to the *ante operam* conditions.

6.2.2.2 Considered mitigation measures

In 2010 the Landscape and Environmental Insertion Plan became part of the project after considering the mitigation measures for the non-significant impacts but the "*landscape and environmental interferences*" (PROTECO, 2012) to occur in the Natura 2000 sites' environment and landscape. The mitigation actions for the environmental insertion includes the following interventions.

Intervention for the landscape insertion and wildlife connectivity:

i. The single arboreal spin of first magnitude
   d. *Populus nigra Italiana*
   m. *Salix babilaonyca*

ii. Single arboreal spin of second magnitude
   c. *Monus Alba*

iii. Single shrub hedge
   e. *comus mas*
   g. *crataeugus monogyna*
   l. *salix purpurea*

iv. Single arboreal-shrub hedge of mixed size of second magnitude

v. Sipe of mixed shrubs

vi. Line of mixed shrubs
vii. Forest/woodland, species:
   Viburnum lantana, Cornus sanguinea, Rhamnus cathartica, Morus alba, Hacer campestre, Prunus avium, Prunus spinosa, Ulmus minor
viii. Meadow with tree species:
   Acer pseudoplatanus, Franix angustifolia, Populus nigra, Quercus robur
ix. Meadow with shrubs
x. a. Permanent pasture
   b. Flowered pasture

xi. Ornamental spots
    b. *Genista hyapanica*
    c. *Rosa tappezzante*

xii. Arboreal-shrub spots for the fauna use
xiii. Hydrophilic hedge
xiv. Climbers to cover the noise barriers
xv. Arboreal-shrub hedges to cover the construction area
xvi. 92 artificial corridors for wildlife:
- 21 above the highway's artificial tunnels
- 2 above the natural tunnels
- 28 paths alongside the cycling path or hydraulic channels near the highway bridges
- 4 under the viaduct passes
- 7 in vicinity to the overpasses
- 8 along the agricultural underpasses
- 2 in proximity to quarries
- 20 irrigated underpasses

xvii. Individual trees

xviii. Noise barriers and sound proofing

All these mitigation areas are created to improve the project insertion into the landscape and to connect the fauna along the fragmented areas (temporary or permanently). Besides, the 6,000 square meters of communal interest habitat 6510 will be restored after the completion of the works in the section 1C (PROTECO, 2012).

6.2.3 Study Area

The *"Superstrada Pedemontana Veneta"* has been taken as a case-study to implement the condition-area metrics proposed in this thesis, as this development project provides with a detailed Environmental Impact Assessment and the related mitigation measures. The section 1 and 2 of the SPV are the area of analysis since the three Natura 2000 sites traversed are present in the Vicenza Providence within the first 56 km of the project (Figure 6).

The three Natura 2000 sites traversed by the SPV in the sections under study are:

i. SSSI IT3220039 "*Le Poscole*" intersected by the section 1, subsection 1C

ii. SSSII IT3220040- "*Bosco di due Ville e risorgive limitrofe*" intersected by the section 2, subsection 2B

iii. SSSI and SPA IT3260018 "*Grave e zone umide del Brenta*" intersected by the section 2, subsection 2C

6.2.3.1 Non-significant impacts accounting for debits

According to the project's EcIA, the *post-operam* restoration of 6,000 square meters of the communal interest habitat 6510 are considered non-significant (PROTECO, 2012) since a bespoke compensation is foreseen by the project after the construction phases is ended. The construction phase will overall disrupt the site, and it is likely that the area kept for *post-operam* restoration will loss considerable ecological value before any restoration actions are completed. Besides, the restoration of an area of such distinctiveness will need a long time for restoration especially because the pristine conditions are most likely to take longer time that the project is accounting for, and so the temporal risk and delivery risks should be considered by the SPV project.

The *post-operam* restoration of 6000 m^2 habitat 6510 were accepted as suitable bespoke compensation by the project and the local authorities, and any kind of biodiversity offsetting project should not replace that commitment. However, the temporary impact can be accounted as interim losses and quantified by the metrics to account for the total habitat debits of the project.

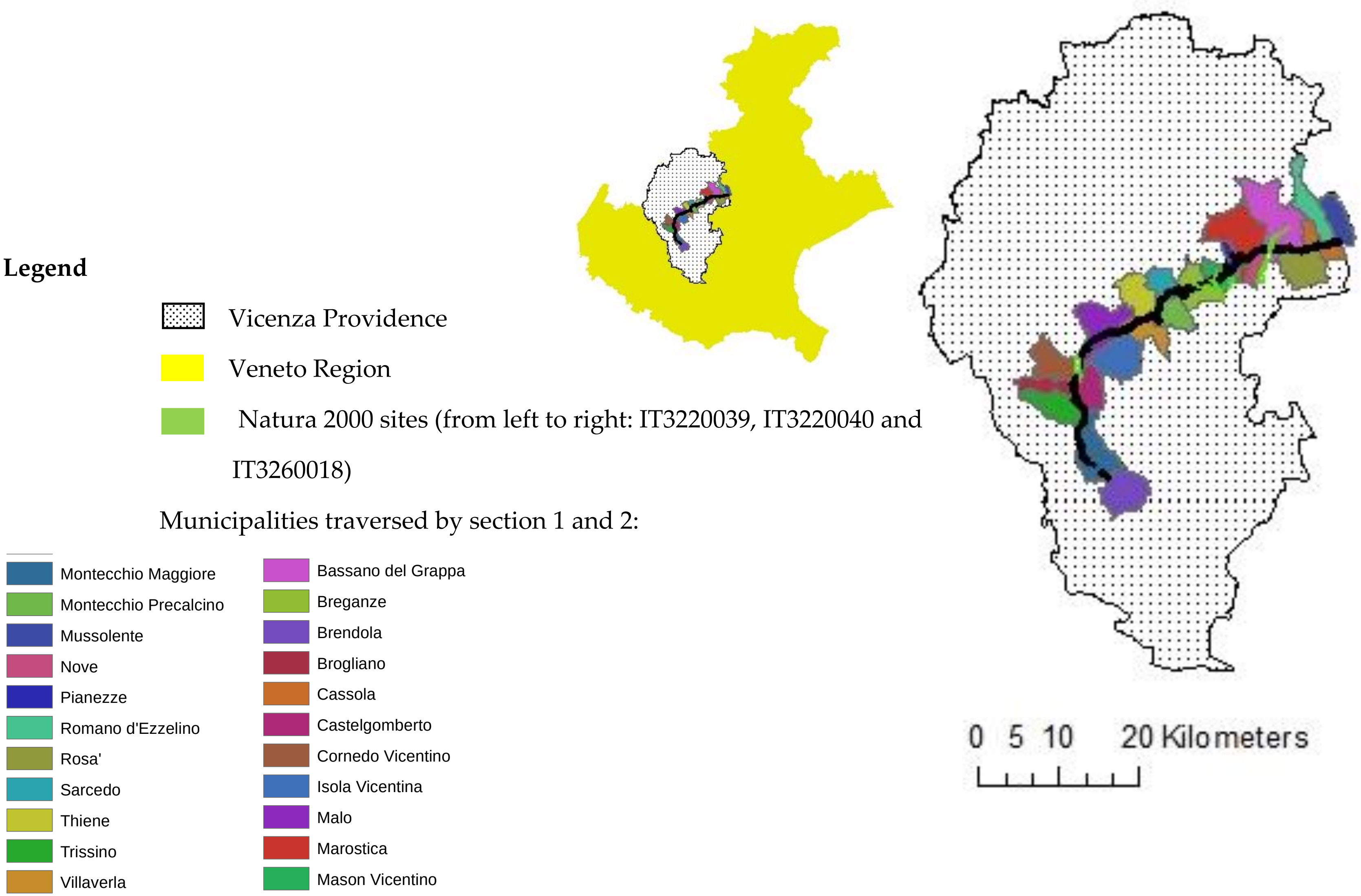


Figure 6. SPV case-study area.

6.2.3.2 Habitat debits calculation

The following sections constitute the application of the metrics to the SPV case-study, first to assess the habitat debits, and second, to scale-up two different options of offset projects.

Assessing the lost habitats in habitat debits

As described before the condition-area metrics of biodiversity offsetting are based on the value of habitats given by its distinctiveness and condition. The compensation of significant impacts over Natura 2000 sites are addressed by existing legislative measures indicated by the Habitats Directive 92/43/EEC, Environmental Impact Assessment Directive 97/11/EEC and Dgr 3173/2006 for the Veneto Region in Italy, and can only be consider for the offsetting calculation if residual/non-significant unavoidable adverse impacts are still pending for compensation. The rest of non-Natura 2000 habitats that undergo land use change, whether permanent or temporary, are identified and quantified to account for the habitat debits.

The superposition of the CORINE Biotopes[29] of the 22 communities traversed by the SPV section 1 and 2 shows the habitat types undergoing permanent land use change. Is important to bear in mind that the SPV project considers the construction of natural and artificial tunnels and bridges that decrease the extension of directly affected habitat. In total, 87.13 ha account for permanent land-use change, and 0.60 ha of the habitat 6510 (equivalent CORINE 38.22) for interim losses (section 6.2.3.1). These two types of direct impacts are accounted as habitat debits, although the indirect impacts due to the soil movement and pillars construction for the tunnels and bridges are not considered by this metrics due to the difficulties for they consideration.

[29] CORINE Biotopes most recent version 2006 available at the Data Catalogue of the Veneto Region under the Territorial Data section, Habitat Types. http://idt.regione.veneto.it/app/metacatalog/index?deflevel=165

The permanent and temporary land-use change data was processed in the Geographical Information System software ArcGIS® (version 10.2.2, year 2014) to obtain the area of the modified habitat type used for the habitat debits calculation (Table 14).

The assignation of the habitat distinctiveness follows the guidance created for this metrics proposal[30] (Annex 1) according to the Italian CORINE Biotopes (version 2006). On the other hand, the habitat condition was assigned to be "moderate" since it was not possible to conduct the habitats survey on the field by following the ISPRA guidelines (Angelini et al., 2013) and the Italian Interpretation Manual of the Habitats (92/43/EEC Directive) (Biondi et al., 2010). The "moderate" level is a midpoint on the condition scale[31] that gives an indicative calculation of the habitat debits. However, in order to consider the differences in the outputs with different values, the "poor" and "good" conditions were used as well (Table 15).

[30] Distinctiveness values assignation are based on the DEFRAs Guidelines (DEFRA, 2012; DEFRA, 2011; Treweek & Temple, 2010; Temple et al., 2010).
[31] Nonetheless, the surveying manual of the Italian Habitats "*Gli habitat in Carta della natura*" developed by ISPRA and updated in 2013, not proposed a means of assessing the condition of some habitat types traversed by the SPV.

Table 14. Offset calculation for habitat lost

CORINE Biotope Code	CORINE Description	Distinctiveness	Condition [a]	Area, ha	Habitat Debits	Offsetting Goal[b]
38.1	Mesophile pastures	3	2	0.056	0.34	Like for like
82.1	Unbroken intensive cropland	1	2	37.95	75.91	Trade up
82.3	Extensive cultivation	2	2	37.62	150.50	Trade up
83.321	Poplar plantations	2	2	0.10	0.41	Trade up
83.324	Locust tree plantations	2	2	0.78	3.14	Trade up
86.1	Towns	0	2	5.77	0	N/A
86.3	Active industrial sites	0	2	3.15	0	N/A
86.41	Quarries	0	2	1.68	0	N/A
TOTAL				87.12	230.29	

[a] The condition of the habitats were considered to be 'moderate' and therefore represented with the value of '2' as indicated by this metrics proposed (Table 11).
[b] The distinctiveness of the habitats is linked to the offsetting goal according with the proposed metrics of this thesis (Table 10).

Table 15. Offset calculation for habitat lost comparing "poor", "moderate" and "good" habitats condition

	Habitat Condition		
Habitat debits	Poor	Moderate	Good
TOTAL	115.14	230.29	345.44

Assessing the interim losses

The EcIA states the temporal loss of 6000 m^2 of the communal interest habitat 6510 due to the construction of a natural tunnel at the SCI IT 3220039 Le Poscole". Yet, no description of the necessary time to recover completely the area was given as it is uncertain and the risk of failure also exist. According with the offsetting objective of compensating all residual unavoidable impacts, the interim losses need to be considered to scale-up the offset. This interim loss has been accounted as the rest of the permanent losses of the SPV based on the following reasons:

- The overall disruption at the site is likely to take off all the biodiversity value of the land and its restoration is more likely to become an area for recreation.
- The unclear restoration objective as it is not indicated the target state the area will be likely to achieve.
- The unknown time for achieving the *ante-operam* conditions of the site.

The following assumptions were considered to account for the habitat debits of the interim losses:

- The area condition is "good" since the description made in the EcIA suggest this area is in favorable circumstances (PROTECO, 2012).

Table 16 show the results of the habitat debits calculation.

Table 16. Habitat debits accounting for the interim losses.

CORINE Biotope Code	CORINE Description	Distinctiveness	Condition	Area, ha	Habitat Debits	Offsetting goal
38.22	Medio-European lowland hay meadows	4	3	0.60	7.20	Bespoke compensation required by the Habitat and Birds Directive Trade in kind compensation considered for the offset

The debits of the interim losses are considered as permanent losses to facilitate calculation and, more important, to contribute with no net loss and preferably net gain of the biodiversity values impacted by the development. Although, the EcIA states this area will be recovered after the development is finished, the time the environment takes to recover until the *ante-operam* conditions should not be underestimated as well as the risk of failure. Thus, considering the interim losses as part of the permanent losses enhances the offsetting achievements toward net gain. Table 17 shows the total habitat debits for the three condition scenarios.

Table 17. Total habitat debits for the three habitat condition scenarios.

	Habitat Condition		
Habitat debits	Poor	Moderate	Good
Permanent land-use changes	115.14	230.29	345.44
Interim losses 38.22 Medio-European lowland hay meadows*	7.20	7.20	7.20
TOTAL	122.34	237.49	352.64

* The debits calculation of habitat 38.22 considers the distinctiveness as "very high" since this is a priority habitat and its condition as "good" according with the description in the EcIA.

Assessing the on-site habitat credits

The SPV project foresees the creation of 15 different mitigation measures on-site that account for habitat credits that diminish the total habitat debits (PROTECO, 2012). To account for these credits it is necessary to consider the risk multipliers of time and delivery, but spatial risk is not applicable, as the mitigations will occur on-site.

Considering the detailed information about species composition, location and actions planning, the 15 mitigation measures were grouped in larger categories of habitat types resulting in 9 different types of biotopes accounting for habitat credits (Table 10) for all SPV under study (section 1 and 2).

The habitat credits quantification considers the following assumptions:

- The distinctiveness scores of the created areas is consider 1 or 2 since the created habitats are identified as modified and heavily modified habitats according with the EcIA description of the mitigation measures, its type, location and species composition.

- The habitat created will be inside the highway area susceptive to water and air pollution due to the automobiles gas emissions and possible chemicals leakage; therefore, it is consider reaching poor condition.

- The delivery risk of the habitats very between low and medium difficulty of recreation or restoration (guidelines in Annex 2).

- The temporal risk varies between 5 and 15 years depending in the type of mitigation measure and species used (Table 10, based in the temporal risk guideline and presented in Annex 3).

The delivery and temporal risk multipliers are crucial when accounting for the habitat credits. In the USA and in the DEFRA's Environmental Liability Directive Guidance use a standard discount rate that goes from 7 % to 3 % to account for the fact that the biodiversity values of the offset will deliver the benefits in the future and not when the impacts are having place (DEFRA, 2012). The discount rate value has been discussed by the National Oceanic and Atmospheric Administration of the US in its paper on Habitat equivalence Analysis (NOAA, 2006) and by a study for the design and use of biodiversity offsets in England conducted for DEFRA (Treweek, J., et al., 2009). In this metrics proposal the discount rate used is 3.5% as recommended by the English Treasury Green Book, since this value seems to reflect the value society attaches to the enjoyment of good and services (DEFRA, 2012).

The number of years to consider and select the temporal risk value is from the time when the impact occurs and the estimated time that will take the offset/mitigation measure on-site to achieve the target condition. To simplify the choosing of the time necessary to create or restore a type of habitat, TEEB 2009 [32] (Besshöver et al., 2009) provides an insight of the type of habitat created/restored and the needing time for achieving the condition goal (Annex 3).

The delivery risk expresses the difficulty to create or restore a habitat based in its inherent nature. The more difficult to create/restore a habitat the more likely to fail the

[32] In the Table 9.1, Chapter 9, page 7 of The Economics of Ecosystems and Biodiversity for national and International Policy Makers, available at http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/National%20and%20International%20Policy%20Making/TEEB%20for%20National%20Policy%20Makers%20report/TEEB%20for%20National.pdf

offset, and hence, larger multiplier value is applicable. Annex 2 presents a guideline for selecting the delivery risk multiplier for a list of different habitat types.

The SPV project plan considers the creation of 9 different types of habitat types identified with the CORINE biotope code. These habitats, once created, account for habitat credits (Table 18) that need to be deducted from the total habitat debits calculated in the previous section in order to obtain the net habitat debits. Hence, the net habitat debits become the target of the biodiversity offsetting project, and the design process bases on this value and the offsetting goal (Table 10 and Table 19).

The mitigation measures consider the creation of hedgerows along the road, these habitat accounts for habitat credits that cannot be directly consider to decrease the total habitat debits because the different measurement unit between the area of habitat impacted given (in hectares) and the length of the hedgerows (in meters or km). Therefore, the hedgerows habitat credits do not account to diminish the total habitat debits based in the following reasons:

- The creation of linear habitats cannot be compared to the area habitats lost by the development since these create habitats of less ecological value, as their distinctiveness cannot be considered equitable with any other type of habitat but hedgerows only.

- The difference is the measurement unit.

Table 18. Habitat types, distinctiveness and condition identification of the SPV mitigation measures on-site.

Mitigation measures					
Mitigation type code*	**Habitat Type**	**CORINE Biotope**	**Distinctiveness**	**Condition**	**Offsetting factor**
i	Hedgerows	85.14	1	1	1
ii	Hedgerows	85.14	1	1	1
iii	Hedgerows	85.14	1	1	1
iv	Hedgerows	85.14	1	1	1
v	Hedgerows	85.14	1	1	1
xiii	Hydric hedgerows	85.14	1	1	1
vi	Shrubland	32.36	2	1	2
xii	Shrubland	32.36	2	1	2
xvi	Shrubs	84	1	1	1
ix	Rough grasslands	84	1	1	1
viii	Grassland with scattered trees	84	1	1	1
xa	Permanent grassland	81	1	1	1
xb	Flowered grassland	85.12	1	1	1
xi	Ornamental shrubland	85.14	1	1	1
vii	Woodland matrix	84.3	2	1	2

*See detailed description of the mitigation type in section 6.2.2.2

Table 19. Habitat credits delivered by the areas created on-site.

Habitat type created	CORINE Biotope	Offsetting factor	Area, ha	Risk multipliers		Habitat credits
				Delivery	Time	
Shrubland	32.36	2	3.4762	1	1.4	4.97
Shrubs	84	1	0.0925	1	1.4	0.07
Rough grasslands	84	1	1.6147	1	1.4	1.15
Grassland with scattered trees	84	1	6.9865	1.5	1.4	3.33
Permanent grassland	81	1	24.12	1.5	1.4	11.49
Flowered grassland	85.12	1	40.502	1	1.2	33.75
Ornamental shrubland	85.14	1	0.2073	1	1.2	0.17
Woodland matrix	84.3	2	4.8358	1.5	1.7	3.79
TOT			81.835			**58.71**

Linear habitat type created	CORINE Biotope	Offsetting factor	Length, m	Risk multipliers		Linear habitat credits, m
				Delivery	Time	
Hedgerows	84.14	1	52798	1	1.2	43998.33

<u>Assessing the net habitat debits</u>

The subtraction of the habitat credits on-site from the total habitat debits result in the net habitat debits. To complete this calculation properly, the offsetting target of the total habitat debits given by the different habitat types impacted is considered, i.e. the habitat credits from the mitigation on-site should only account for the equivalent habitat debits or those with trade up goal (see Table 14). Therefore, the eight habitat types accounting for habitat credits can be consider to diminish the habitat debits of most of the habitat lost except for the loss of the priority habitat 6510. The habitat created can even deliver equivalent environmental services that compensate for some of the debits on the habitat

38.1 needing in kind compensation (Table 14). Nonetheless, the compensation of the habitat 6510 (CORINE code 38.22) need to be completed as the local authorities required, as described in the EcIA, and in this case, the interim losses of such habitat accounted as habitat debits would need trade in kind compensation.

The habitat credits delivered by the mitigations on-site decrease the habitat debits of the habitats with trade up goal. However, the impacted habitats of CORINE biotope code 38.22 and 38.1 requiring trade in kind and like for like offset goal remain with the same habitat debits since the mitigation measures will not deliver habitat credits of equitable offsetting goal (Table 20).

The hedgerows deliver also habitat credits that do no decrease the total habitat debits because their linear units do not compare with the area units of the rest of the debits. Also, because linear habitats cannot be compared to the area habitats lost by the development since these create habitats of less ecological value, as their distinctiveness cannot be considered equitable with any other type of habitat but hedgerows only. In this case, the total habitat debits needing compensation with offsetting the goal of "trade up" are 171.25, and with 7.54 with the "trade in kind" goal.

Table 20. Equivalency of habitat debits and habitat credits on-site, scenario considering habitat lost in "moderate" condition.

Offsetting goal	CORINE biotope lost	Habitat debits	Corine biotopes created	Habitat credits on-site	Net Habitat debits
Trade in kind	38.22	7.20			7.54
Like for like	38.1	0.34			
Trade up	82.1	229.95	32.36	58.71	171.24
	82.3		84		
	83.321		81		
	83.324		85.12		
			85.14		
			84.3		
	TOT	237.49		58.71	178.78

Simplifying this calculation for the other two condition scenarios, the net habitat debits change in +/-115.15 habitat debits units as shown in Table 21.

Table 21. Net habitat debits for "poor", "moderate" and "good" condition scenario of the habitat lost.

	Condition scenario of habitat lost		
	Poor	Moderate	Good
Total habitat debits	122.34	237.49	352.64
Total habitat credits on-site (area based)	58.71	58.71	58.71
Net habitat debits	63.63	178.78	293.93

Results of habitat debits calculation

The SPV construction of section 1 and 2 (55.85 km long) will impact 87.12 hectares having permanent land use change (Table 14). And 7.20 hectares of priority habitat 6510 (38.22 CORINE biotope code, Table 16) will be disrupted during the construction phase and not recovered until their restoration. In total, 87.73 ha of nine different types of habitats account for 237.49 habitat debits considering the "moderate" condition scenario of the habitats lost, this is in average 2.71 habitat debits per hectare.

The most impacted land by the SPV construction are unbroken intensive cropland and extensive cultivation (82.1 and 82.3 CORINE biotope, respectively) that together score for 75.58 ha, i.e. 86.15 % of the total hectares needed for the project, and 95.33 % of the total habitat debits (calculated with "moderate" condition scenario).

Considering the habitat debits created on-site, the net habitat debits score 178.78 units (calculated with "moderate" condition scenario) due to the 58.71 habitat credits meant to be delivered on-site. 95.78 % of these net habitat debits can be offset with trade up goal, while 4.22 % would need in kind compensation. In the case of "poor" and "good" condition scenarios, the net habitat debits score by +/- 115.15 units from the moderate condition.

The project also considers the creation of 52,798 meters long of hedgerows that will deliver nearly 44 km of linear habitat credits. Such credits are not considered to decrease the total habitat debits since the impacted areas and credit units are not equivalent. Hence, these credits would account for extra credits if an offsetting project was conducted by the developer.

6.2.3.3 Designing the offsetting project

The *Superstrada Pedemontana Veneta* will change the land use of 87.72 ha of nine different habitats, accounting for 178.78 net habitat debits needing compensation. The net habitat debits represent the value of biodiversity loss that would need to be compensated through additional conservation activities in other locations considering the offsetting goal of the impacted habitat. This section presents two explorative alternatives of how the compensation could be achieved.

There are three offsetting possibilities to design compensation according with their location:

A. Offset project for the restoration within Natura 2000 sites, mainly the areas identified by the Italian Prioritized Action Framework.
B. Offset project planned to buffer, link, restore or expand the near areas of Natura 2000 habitats.
C. Offset project not linked with priority areas.

According to the spatial risk multiplier, the habitat debits delivered by an offset are influenced by their location. Offsets are likely to deliver better results when located in the right place according to the type of ecological actions. It should be decided together with the local authorities the best areas to locate offset projects to contribute to the ecological planning. Besides, locating the offsets strategically in areas with more potential to deliver better ecological results will reduce the risk of failure if the offsets is placed less favorable areas. The involvement of the local authorities in offset projects would deliver better and bigger biodiversity values accounting for positive actions in favor of the local biodiversity status, and so, would contribute with the regional and national biodiversity conservation goals.

The principle 4 of this offsetting metrics proposal (section 6.1) considers additionality as an important feature to consider when designing the offset. As stated by the BBOP principles[33] the additionality means that the offset should be supplementary to the already planned or implemented activities to conserve biodiversity, and should enhance the management of local habitats. Thus, the option A for the offsetting possibility wouldn't comply with this criterion. This does not mean that a project or scheme cannot be built to co-fund the management of Natura 2000 sites in Italy, but that such initiative should be created and launched by the authorities considering the prioritized Natura 2000 network.

The offsetting option C would mean to compensate for the SPV impacts in areas far away from the debits location and that the biodiversity values will not be given back to the environment impacted and people that may benefit from them. The spatial multiplier distinguishes this issue by adding a higher value for those areas of offsets not linked with the impacted site, but does not reflect the different possibilities that an offset can have. Compensation within the same municipality, region, state, country or even international compensation could exist in the voluntary basis. Thus, the option of upscaling an offset not linked with the SPV development project is not considered. Still, more research on spatial risk multipliers is needed in order to better consider the distance between the impact and the offset.

[33] http://bbop.forest-trends.org/documents/files/bbop_principles.pdf

Option B is taken as the offsetting possibility to upscale compensation of the SPV net habitat debits since it considers the additionality principle by enlarging/enhancing the status of buffering areas of Natura 2000 sites. Besides, this option allows developers to compensate the impacts near the impacted site, and hence, reduce the spatial risk. Two different hypothetical offsetting projects are developed in the following sections to compensate for the net habitat debits of the SPV project.

The first offsetting option addresses the invasive species issue in the buffering areas of the Natura 2000 site IT3260018 "*Grave e zone umide del Brenta*" intersected by the project's section 2, subsection 2C. There is evidence about the need of management activities within protected areas against alien species (Celesti-Grapow; et al., 2009; Blackburn et al., 2014), and this problem also exists in the SSSI IT3260018 according to the literature and ecologist familiar with the area (Celesti-Grapow; et al., 2009). While the second offset, calculates the habitat credits of a real project of land use change were 2.5 ha of intensive maiz cropland has been transformed into a forest plantation (CORINE biotope 83.3) in the adjacent municipalities of the SPV.

<u>Offsetting project 1: Management of hop-hornbeam riparian forest</u>

An offsetting project to compensate for the SPV net habitat debits is explored to manage the hop-hornbeam riparian forest buffering area of the Natura 2000 site IT3260018 "*Grave e zone umide del Brenta*".

Two areas of hop-hornbeam riparian forest (CORINE biotope 44.61) buffering the Brenta river priority site were identified using GIS, and selected as receptor sites for this hypothetical offsetting project. The areas are located in the municipality of Bassano del Grappa and score for 8 ha in total (Figure 7). To assess the habitat credits delivered by the offset (considering the enhancement of these areas) the following assumptions were considered:

- The net habitat debits of the SPV needing compensation score 178.78 units (moderate condition scenario).

- The current condition of the offset receptor areas is “poor” due to the presence of the invasive species *Robinia pseudoacacia* and the target condition after the management is “good”.

- The current and target condition of the receptor sites is comparable as the areas are uniform in type.

- The distinctiveness of the offset receptor area is very high since the hop-hornbeam riparian woods are in fact categorized as priority habitat 92A0 (CORINE biotope 44.61), according with the code of the interpretation Manual of European Union Habitats, EUR28 (Annex 1).

- The delivery risk is medium (1.5) since the management of the area can involve a combination of different ecological actions that may change the current habitat equilibrium.

- The time needed to reach the good condition after the management activities is 10 years (temporal risk = 1.4)

- The management of hop-hornbeam riparian forest habitat 92A0 (CORINE biotope 44.61) can offset the net habitat debits of the impacted habitats needing in kind compensation (with CORINE biotope code 38.1 and 38.22).

An excel model was built to calculate the habitat credits delivered by the offset receptor sites (Annex 4). The model calculates the credits available from the receptor site in its current condition and the habitat credits potentially delivered when achieving the target condition considering the risk multipliers. The target habitat credits minus the current habitat credits give the deliverable habitat credits by the receptor sites. Table 22 shows the results of this calculation for the theoretical receptor sites of hop-hornbeam riparian forest. In total these areas can deliver 3.81 credits/ha, thus, 46.93 ha of this habitat type would be needed to offset the 178.78 net habitat debits of the SPV project.

Along the SPV there are more areas of hop-hornbeam riparian forest that could be used to offset the net habitat debits. In total, there were identified 519 ha of hop-hornbeam riparian forest only in the Vicenza providence (Figure 8, shows the areas in Vicenza and Treviso). Some of those areas could be included in the offset project in order to completely compensate for the 178.78 net habitat debits.

Table 22. Habitat credits delivered by the hop-hornbeam riparian forest receptor offset site

Receptor offset site area, ha	Condition		Distinctiveness	Multipliers			Habitat units		Deliverable habitat units/ha	Habitat 44.61 necessary to offset, ha
	Current	Target		Delivery	Spatial	Time	Current	Target		
8	1	3	4	1.5	1	1.4	32	96	3.81	46.93

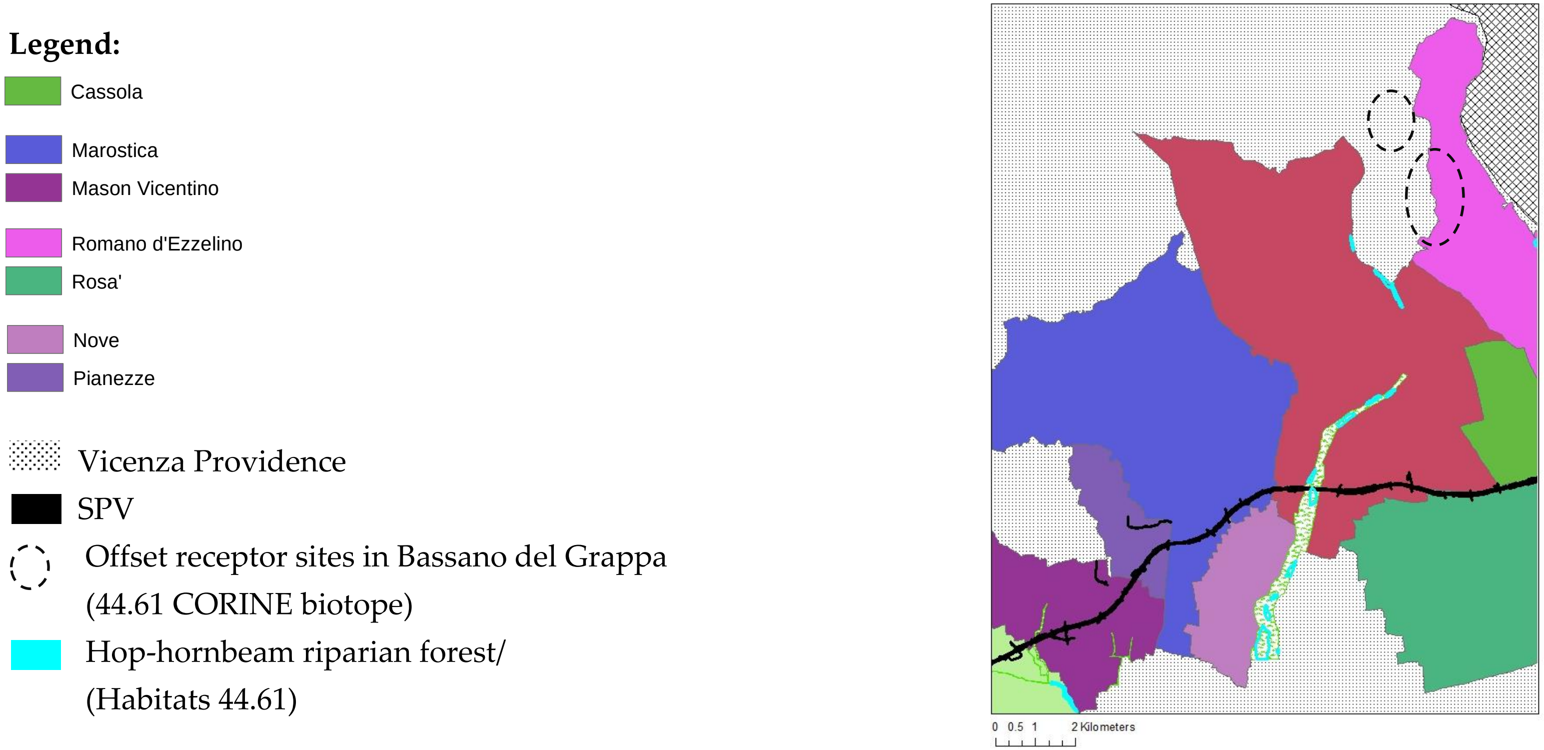


Figure 7. Offset receptor sites hop-hornbeam riparian forest in Bassano del Grappa municipality.

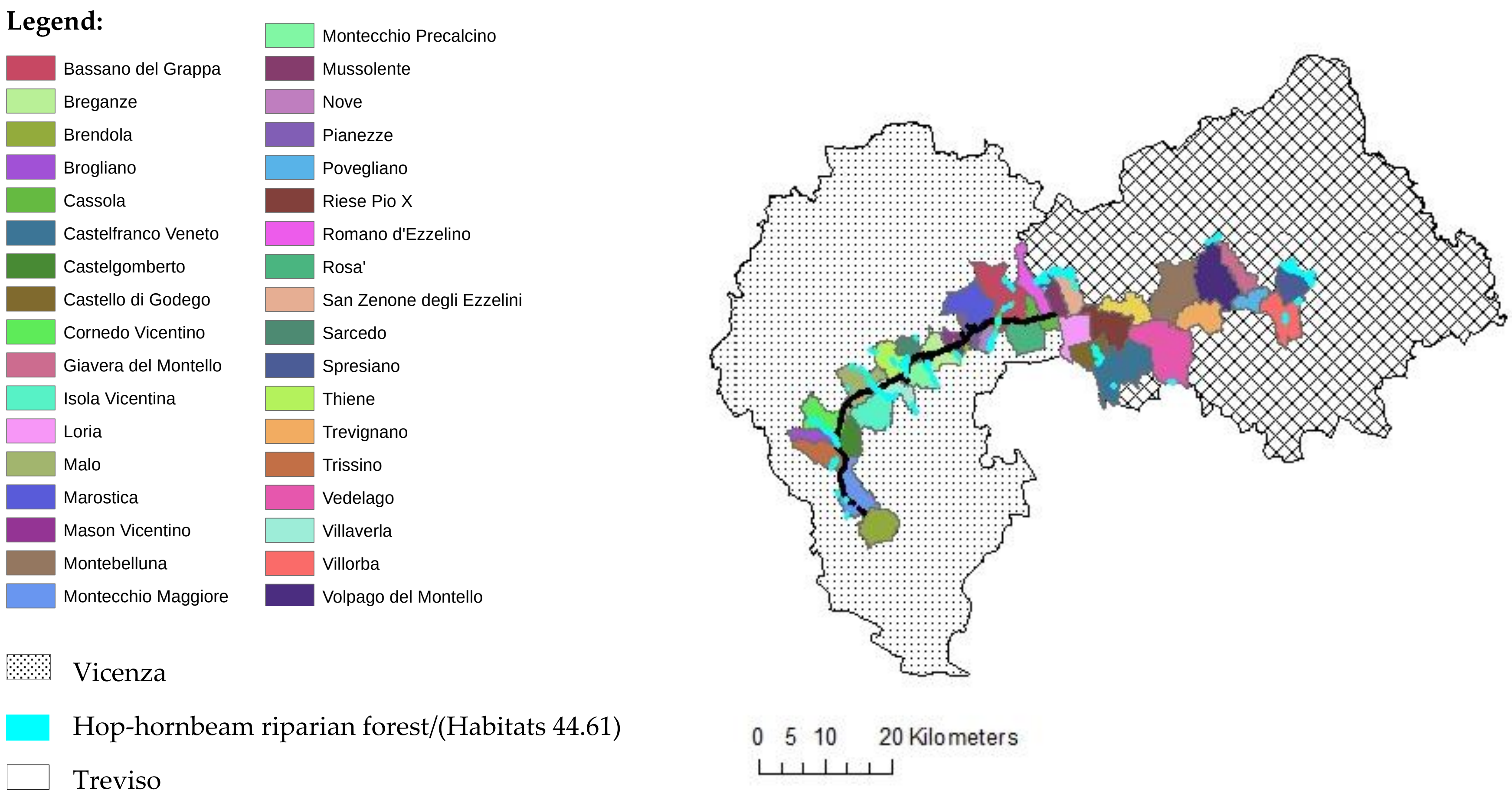


Figure 8. Potential offset receptor sites of hop-hornbeam riparian forest along the SPV (section 1, 2 and 3).

Offsetting project 2: wet woodland plantation

The wet woodland plantation project *Bosco Limite*[34] is a real initiative launched in 2011 to create new forest lands in the lowlands of the northeast Italy. The conversion of a extensive maize monoculture into wet forest lands has been considered as a possible offset for the SPV impacts since the activity was carried out by a private landowner as an innovate manner to generate income from a more sustainable activity, that in fact can have interesting income sources compare to the maize revenues.

The conversion of 2.5 ha of maize fields into forest plantation with fresh water channels (CORINE biotope 83.32 and 89.2) is considered an offset possibility for delivering habitat credits to compensate for the SPV impacts (Figure 8). The calculation of the habitat credits consider the following assumptions:

- The net habitat debits of the SPV needing compensation score 178.78 units (moderate condition scenario).

- The wet woodland plantation (CORINE biotope 83.32 and 89.2) can offset the net habitat debits of the impacted habitats needing in-kind compensation (with CORINE biotope code 38.1 and 38.22).

- A suitable plantation and management plan has been developed to create a wet forestland of 4 different tree species, genus Quercus, Ulmus, Fraxinus, Carpinus, and several different fruit bushes and truffle trees.

- All the habitat credits delivered by the offset receptor areas come from its transformation into a forest plantation. The assumption is that none of the forest plantation delivered credits are diminished by the previous lost maize cropland due to its low ecological value.

- The distinctiveness of the woodland offset is "medium" since the forest plantations are classified as modified areas with CORINE biotope code 83.32, and the artificial fresh water channels of the forest have low distinctiveness, according to the habitat type distinctiveness value (Annex 1).

[34] www.boscolimite.it/

- The delivery risk for the wet forest plantation is medium (1.5) as the project needs the effort to create a good and strategic plan and regular management operations. On the other hand, the freshwater channels creation has low creation creation difficulty (Annex 2).

- After 15 years, the wet forest plantation will reach poor condition (temporal risk = 1.7), as a woodland is very likely to need decades to mature and become a natural habitat for local animal species. Meanwhile, the freshwater channels will start functioning earlier and reach a good condition in about 5 years since.

The credits calculation model in Annex 4 was used to assess the habitat credits delivered by the offset receptor site using the input data for the 2.5 ha of forest plantation CORINE 83.32 and 1200 meters of linear freshwater channels (Figure 9). This separated calculation was due because there is not information about the distinctiveness of wet woodland plantations in the list of CORINE biotopes for the Italian habitats (Annex 1). Thus, the water services delivered by the freshwater channels are accounted knowing that the 12000 m^3 are infiltrated annually into the water table, among 8 ground water wells located in the Cammazzole di Brenta and Carmignano di Brenta municipalities.

The creation of 2.5 ha of lowland wet forest (Table 23) would deliver 2 credits/ha, thus, 89.39 ha of this habitat type would be needed to offset the 178.78 net habitat debits of the SPV project. The 1200 m of linear freshwater channels of Bosco limite account for 3 linear habitat credits/m. As in the case of the hedgerows included in the mitigation measures, the linear credits delivered by the freshwater channels cannot be used to estimate the total number of credits this kind of habitat would be needed to offset the net habitat credits. The reasons are because this habitat forms part of the wet woodland plantation project which by its self wouldn't deliver the equivalent ecosystem services the SPV impacts need to compensate.

Thus, the credits delivered by the freshwater channels (Table 24) account for extra credits that could be used to compensate the environmental impacts of the pillars used for the bridge construction over the Brenta River included in the SPV project. In this case-study analysis, the data needed to account for these specific impacts is unknown, and hence, the linear habitat credits delivered by the freshwater channels of this offsets contribute to the offset's net gain objective.

Comparing with the offset presented in the previous section, the management of hop-hornbeam riparian forest to control invasive species, the Bosco limite forest plantation creation would deliver fewer habitat credits than an offsetting with higher distinctiveness. However, the deliverable environmental services and credits are very valuable because represent a real possibility enlarging the buffering area of the Brenta River Natura 2000 site according to with the Municipality's Land-Use Plan, and so, can deliver additionality to protected sites near the impacted area.

6.2.3.4 Results and analysis of the offsets habitat credits calculation

The 178.78 net habitat debits of the SPV could be compensated with either the offset 1 or offset 2 proposed above. As identified in the EcIA, the permanent impacts over the environment due to the SPV construction are the permanent land use change, habitats extension reduction, and greenhouse gases, noise and vibrations emission from the road in use. Besides, the temporary negative effects related with the construction phase as the sediments movement, the pollutant gases from the construction equipment, the particles suspended due to the transport of material and construction, and the temporary occupation of the environment as construction site (PROTECO, 2012).

The EcIA does not describe the environmental functions and services lost after the SPV construction, but those can be drawn after the analysis of the habitat debits calculation, from the identification of the habitats types undergoing permanent and temporal land-use change. Therefore, the environmental functions and services impacted by the SPV construction can be identified as the following:

- Food and revenue delivered by the permanently impacted lands of extensive cultivation and unbroken intensive cropland (CORINE biotopes 82.3 and 82.1)

- Water filtration and regulation important for the water table of the SSSI IT3260018 "*Grave e zone umide del Brenta*" delivered by the locus tree plantations (CORINE biotope 83.324)

- Cultural and cattle food provisioning delivered by mesophile pastures (CORINE biotope 38.1)

- Habitat for protected species and wellbeing inspiration from nature delivered by the temporary impacted protected site SSSI IT3220039 "Le Poscole".

The trade up and in kind offsetting goal required by the habitat debits calculation using the proposed metrics suggests the environmental impacts identified can be equitable compensated whether by the offset 1 or 2. The like for like compensation goal for the Both projects would contribute to enhance priority habitats that would address the biodiversity losses over the SSSI IT3260018 "*Grave e zone umide del Brenta*", and so target, the provision of water filtration and regulation service, as well as protected species habitat provisioning and wellbeing inspiration.

The management of one hectare of hop-hornbeam riparian forest would deliver 3.81 credits. Thus, 46.93 ha of this habitat type would be needed to offset the 178.78 net habitat debits of the SPV project. This offsets project is possible since there are nearly 519 ha of hop-hornbeam riparian forest only in the Vicenza providence (Figure 8, shows the areas in Vicenza and Treviso). Some of those areas could be included in the offset project in order to completely compensate for the 178.78 net habitat debits. This kind of offset project would, in fact, be desirable to provide management of priority habitats invaded by alien species in the northeast Italy.

The creation of wetland forest is the second offset proposal. This kind of project is indeed an attractive way to compensate for residual impacts of development projects since the developers could support the delivery of environmental services by private landowners and seek for more sustainable ways to receive revenue for their land. In total, the creation of 2.5 ha of wet woodland plantation could deliver 2 credits/ha, thus, 89.39 ha of this habitat type would be needed to offset the 178.78 net habitat debits of the SPV project. Besides, 3 linear habitat credits/m can be delivered by the creation of freshwater channels inside the forest plantation.

Table 23. Habitat credits delivered by the wet woodland plantation offset CORINE biotope 83.32.

Receptor offset site area, ha	**Condition**		**Distinctiveness**	**Multipliers**			**Habitat units**		**Deliverable habitat units/ha**	**Habitat 83.3 necessary to offset, ha**
	Current	**Target**		**Delivery**	**Spatial**	**Time**	**Current**	**Target**		
2.5	N.A.	1	2	1.5	1	1.7	N.A.	5	2	89.39

Table 24. Linear habitat credits delivered by the freshwater channels, CORINE biotope 89.2, included in the wet woodland plantation offset

Receptor offset site, m	**Condition**		**Distinctiveness**	**Multipliers**			**Habitat units**		**Deliverable habitat units, m**
	current	**target**		**Delivery**	**Spatial**	**Time**	**Current**	**Target**	
1200	N.A.	3	1	1	1	1.2	N.A.	3600	3

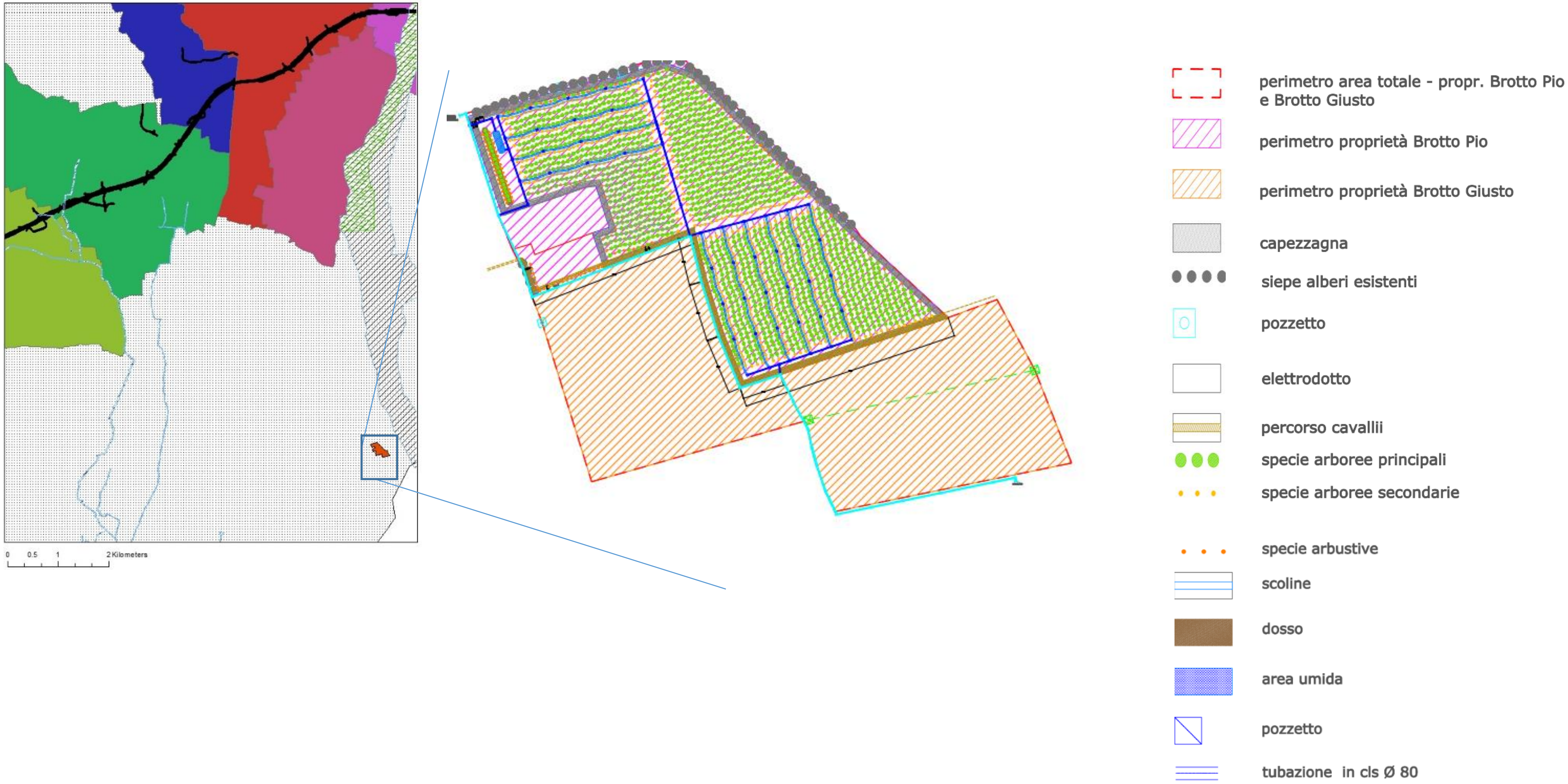


Figure 9. Location and forest plantation plan as a potential offset.

6.2.3.4 Pedemontana case-study conclusions

This metrics give a pragmatic model to assess the residual environmental impacts of development projects and offers a replicable methodology to propose offsets that, only after the development mitigation hierarchy consideration, would contribute to no net loss of biodiversity in Italy and Europe. Nonetheless, by the applicability of the metrics proposal to the Pedemontana Veneta case-study suggests that a revision and consensus by experts is needed to set suitable values for the spatial multiplier. This component is, in fact, one of the most important of the metrics since it directs the offsets efforts towards the most needed areas, so the local and national authorities opinion would indicate the priorities towards biodiversity offsetting could be a powerful tool to manage, enhance or restore.

The temporal risk and distinctiveness values also need revision and consensus by experts in EIA to better suit for the Italian habitats. The condition assessment of the impacted habitats is just a guideline and need to be revised in case by case basis according to the impacted sites and the offset receptor areas.

Both offsetting project options analyzed for the *Superstrada Pedemontana Veneta* case-study illustrate the potential that a market-base mechanism can have to compensate for the environmental impacts of development projects, as it could become an important source of funding to manage buffering areas of priority habitats and/or deliver payment for ecosystem services to private farmers and landowners.

CHAPTER

SEVEN

EMPIRICAL APPLICATION OF BIODIVERSITY BANKING IN THE USA

This chapter presents the biodiversity banking regulation and empirical application of the US biodiversity banking (US BB) schemes, Conservation Banking and Mitigation Banking. It describes how the demand and supply side meet in the market of biodiversity credits, and the factors that make US BB the most experienced BB in the world. The practical challenges of implementing and managing BB throughout time from the regulators and practitioners' perspectives are here discussed too. Finally, this chapter presents the results and conclusion of a survey addresses to conservation banking practitioners and regulators in the US to study the features and challenges of the most experienced market-based offsetting mechanism.

7.1 Biodiversity banking regulations in the USA

The foundations of BB started in the USA in the 1980's. Since the establishment of the first official wetland mitigation bank in 1984 'Tenneco La Terre' in Louisiana, and the primary conservation bank 'Coles Levee Ecosystem Preserve' in Kern county California in 1992, the USBB progressively implemented laws initiating the "*incentive-based instruments era*" for biodiversity compensation.

The policy milestones of BB were first published in the 70's with the regulation on Wetland Mitigation Banking (MB) (Robertson, 2006), the National Environmental Policy Act (1971), and the California Environmental Quality Act (1972). However, it was until the enforcement of the Federal Water Pollution Control Act (FWPCA, 2002), better known as the Clean Water Act (CWA, section 101) of 1972, and the Food Security Act (FSA), that legal bindings for projects jeopardizing wetlands were established.

For nearly a decade, the requirements of the CWA (section 404) and the FSA were complied with bespoke compensations resulting in scattered small on-site or off-site mitigation of low ecological values (DeWeese, 1994; Marsh et al., 1996; Redmond et al., 1996, and Environmental Defense Fund, 1999). The noticed disadvantages of project-by-project mitigation (i.e. permittee-responsible) were mainly: the time gap between the impacts and their offset, the substantial transaction costs, expensive land costs, and the time needed to achieve equal compensation on the ground (Thorne et al. 2014; Boisvert, 2015). Therefore, in the 1980s the USACE started approving wetland banks (Mead, 2008), and in 1995[35] it unveiled the final interagency Federal Guidance on the establishment, use and operation of MBs. With this, and the Transportation Equity Act of 1998, MB became the preferred compensatory mitigation alternative for impacts on wetlands involving Federal funding (USEPA, 2014).

[35]Besides the USACE, the guidelines were also approved by USFWS, EPA, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA's NMFS), and U.S. Department of Agriculture's Natural Resources Conservation Service.

In the light of achieving better-performing habitat reserves, and seen the supporting guidance for MB, the banking concept enlarged into conservation banking (CB) for listed endangered and threatened species (ESA of 1973[36], 16 U.S.C. 1531 et seq.) for the first time in 1973. In 1995, the California Fish and Game published the official policy on conservation banking (Wheeler and Strock, 1995) reinforcing the development of BB.

7.2 Biodiversity credits supply addressing US regulations

Developers have the opportunity of purchasing credits from biodiversity banks when suitable credits are available to fulfill with the compensation required by the environmental agency (Vaissière and Levrel, 2015). The main reasons developers prefer BB besides permittee-responsible compensation are: (i) BB is more cost and time effective (Eppink and Wätzold, 2009; Vaissière and Levrel, 2015; van Teeffeelen et al., 2015), thanks to its higher likelihood of achieving better ecological performance in comparison with other BO mechanisms (DeWeese, 1994; Marsh et al., 1996; Remond et al., 1965; EDF, 1999). This reduces the costs of compensation and the risk of poor ecological performance that is often derived from the permittee-responsible offsets. (ii) The time needed for project approval may significantly decrease if the offsetting credits required are already available[37]. (iii) The compensation liability is transferred from the permittee to the bank sponsor[38], hence all costs related with the compensation site management and long-term sustainability are also transferred. (iv) The acquisition of offset credits provides better assurance of compensation success because banks are

[36] The section 9 of ESA prohibits the take of endangered species, marine and anadromous administered by NOAA, and by USFWS. Nonetheless, section 7 allows species incidental take to projects with federal nexus through an incidental take statement (ITS). Whereas section 10 allows private developers to receive authorization through a Habitat Conservation Plan (HCP) accompanying the application for an Incidental Take Permit (ITP).

[37] This is possible if the regulatory agency is extending a positive biological opinion after the definitive project version has been presented including an EIA.

[38] In the case of private and/or public commercial banks in USA the liability is directly transferred from the developer to the banker (USEPA, 2014; Mead, D., 2008). For private and/or public single-user banks (i.e. non-commercial), the permittee keeps the compensation liability, and often the jeopardized environmental assets are directly written into the banking instrument.

regulated by agencies requiring the bank to comply with ecological and economic performance standards[39] (Hanski, 1999; Mead, 2008; Thorne et al., 2014).

The reason of BB popularity and favorable outcomes in the USA do not limit to the business attainment of bankers (Madsen et al., 2010; Madsen et al., 2011; Denisoff and DeYoung, 2011). It also includes the conservation achievements, practitioners have encountered for species, habitat and the linked ecosystem functions (Denisoff and DeYoung, 2011; USFWS, 2013; Bunn et al., 2014a; Mann and Absher, 2014). Currently, there are 136 approved[40] conservation banks and 1375 approved mitigation banks in the USA (RIBITS, 2016). The significant difference between the number of existing conservation banks and the mitigation banks can be attributed to the fact that MB policies were developed primary, roughly 10 years before the CB policies, giving MB a significant advantage over CB to evolve and be implemented.

The mitigation banks are widely distributed in the USA, while conservation banks are more present in the Pacific west coast, except for Texas and Florida (Figure 10). California is by far the State with more CBs due to its pioneering State policy development, scientific research on ecosystems management and sustainability, and the availability of suitable sites with endangered species presence. On the other hand, Texas and Florida have embraced the Federal mitigation and conservation policies and developed their protocols to implement numerous banks that are, nonetheless, mostly MB.

[39] Often by planning contingency actions for the case of the bank financial or ecological failure (ELI, 2002).
[40] Including the 21 sold-out banks.

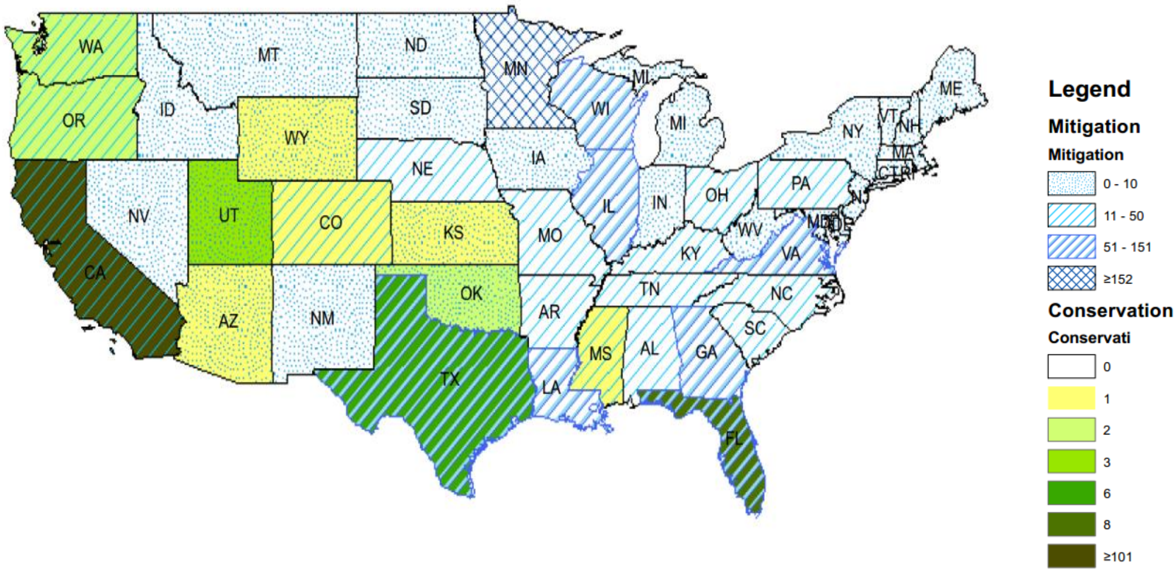


Figure 10. Location and quantity of conservation and mitigation banks in the USA (map constructed from RIBITS, 2016 by the author).

According to RIBITS, 85% of all approved American conservation banks are commercial, among which only the 6% are public. Whereas, 75% of the total mitigation banks are commercial, among which 7% are public banks. In essence, more than 90% of approved commercial banks are privately owned. These data reflect the strong market drivers of MB and CB although the high cost of delivering compensation in advance of development projects. The related risks and upfront capital investment that bankers need are reflected on the final price of compensation credits. The long-term credits assurance is incorporated in the credits price. Approximately, 25 to 30% of the price per one conservation/mitigation credit in the USA appertain to the risk that bankers assume and buffer, i.e. the uncertainty of economic downturns reducing the credits sales, the time need to sell all delivered credits, and the upfront capital needed to cover the costs of land purchase, taxes, conservation easement[41] fees, permitting expenses and upfront financial assurance (needed to complete the restoration/establishment construction actions, assure contingency protection and the initial management and monitoring).

De facto, there are three key elements that allow MB and CB to be self-sustainable through time: (i) the ecological features of the site and its short-term funding, (ii) real state assurance, and (iii) long-term management and stewardship funding. These three factors are crucial to get a bank legally approved and to diminish the risk of failure:

- First, reaching and maintaining the required biology and ecology of the site through a suitable management plan. The short-term financial assurance is decisive at this phase since it allows covering the up-front costs of restoration, enhancement or establishment of the bank. There are different mechanisms to secure the short-term financial assurance as cash escrows, letters of credit, performance bonds, insurances, endowments and legislative enacted dedicated funds for government-operated banks or similar instruments. One of these options may be selected on a case-by-case basis according to with the financial scale of the sponsoring biodiversity bank and the guidelines set by the approving agencies involved (the bank review team).

- Second, the real state assurance clarifies who own the property and which rights are attached to it. The most common instrument used are the conservation easements. However, other restrictive covenants are used as multiple party agreements, title transfer and contractual documents (i.e. land-trust).

[41] Conservation easement is a "*recorded legal document established to conserve biological resources in perpetuity, and which requires certain habitat management obligations for the conservation bank lands*" (USFWS, 2003, page 17).

- And third, the long-term financing is achieved through a conservation/mitigation endowment delivering enough funds to manage and monitor the bank in perpetuity, or as long the regulation requires.

Considering these three key elements and other necessary actions to enable a new bank in the USA, the time needed to its approval may vary from 3 months up to 7 years, as seen from the California experience in CB (Bunn et al., 2014a; Layne and Rowan 2015).

7.2.1 Considerations to value the cost of credits

The task of assessing the cost of credits is linked to a set of transactions and foreseen management than the banker should consider when creating a for-profit conservation and/or mitigation bank. First, the expected cost of selecting the receptor land to establish the compensation site. Then, the acquisition or the rent of the land. The cost or rent will depend on three main aspects: (i) the demand for credits due to for instance an urbanization phenomenon, (ii) the number of green zones available close to the urban area demanding biodiversity credits, and (iii) the occurrence of the needed area with the desired species and habitat presence.

Having acquired the future compensation site, the banker usually executes ecological studies to estimate the expected natural improvement after the restoration activities are put in place on the ground. This will support the reason of creating a conservation or mitigation bank in the area selected and the expected effectiveness of the banker's actions that the agencies would expect to grant authorization for the bank creation. The cost of such studies is additional to the expected initial and long-term management cost of the site.

After having improved biodiversity on the compensation site, the banker ask authorities for the legal agreement to sell credits. At the signature date, the banker obtains the right to sell the credits. At this point some time has passed since the site was set ready for the restoration actions and to be ready to deliver sufficient ES that will be transferred into the tradable biodiversity credits.

A risk factor that can increase the credits monetary value is the phenomenon of 'speculation'. Such speculation means that the anticipated expectations that the chosen receptor site for a conservation bank will have the presence of the species of importance that are credited in conservation banking. In some cases, bankers could try to acquire inexpensive lands where they foresee future high rate of urbanization. With time, the expectation becomes a reality, and the urbanization increases the demand for the bank's credits. By acquiring the land before, the banker can decrease the cost of the land but will face the cost of having to wait for the credits to be sold.

For public or private commercial banks, the economic objective is to make a profit. To do so, bankers study the urban growth and make decisions on where to establish a bank and what kind of species to conserve, because the process of creating and getting approval for the bank to start selling credits can range from 2 to 7 years according to with the experience of Conservation Banking in California.

7.3 The role of agencies and developers

7.3.1 The authority of agencies

In any BB scheme, there could be a considerable, extensive list of different stakeholders related to an offset depending on the project size and ecosystem assets, the setting-up appraisal, the agencies involved, the investors, and the clarity of regulatory guidelines, among other factors that might come along the offsetting process. The recognized stakeholders involved in USBB can be grouped into 5 categories:

1) **Government**: City, county, state agency, special district and/or joint powers authority;
2) **Private parties**: individual, corporation and Limited Liability Companies (LLCs);

3) **Non-profit organizations**: conservation organizations, Land Trust Community Foundation and/or communities. This commonly known 'Land trusts', are non-profit organizations focused on land conservation funding conservation easements to protect land for its ecological value.;
4) **Public agencies (regulators)**: Federal, State, local;
5) **Project proponents**: individuals, entities or public agencies.

Depending on those entities' interests it can appear that their roles are very well distinguished, however, in practice, some of their functions are shared, overlapped and/or intertwined (Figure 11). For example, the tasks of a land purchaser, a fee simple owner, a conservation easement holder, an endowment manager, a long-term steward and a third-enforcer principally can be easily overlapped if they need to become the conservation easement holder and so, execute the needed management and or overlook of the site to be kept in compliance with the regulatory agencies. This overlapping and intertwining of functions help developers, bankers and regulators to interact in the conservation banking process and improve communication making the scheme more transparent. For example, in USBB regulators do not indicate developers from whom they can purchase their needed credits, but help them in this task by setting up instruments like RIBITS, where developers meet their potential credit suppliers.

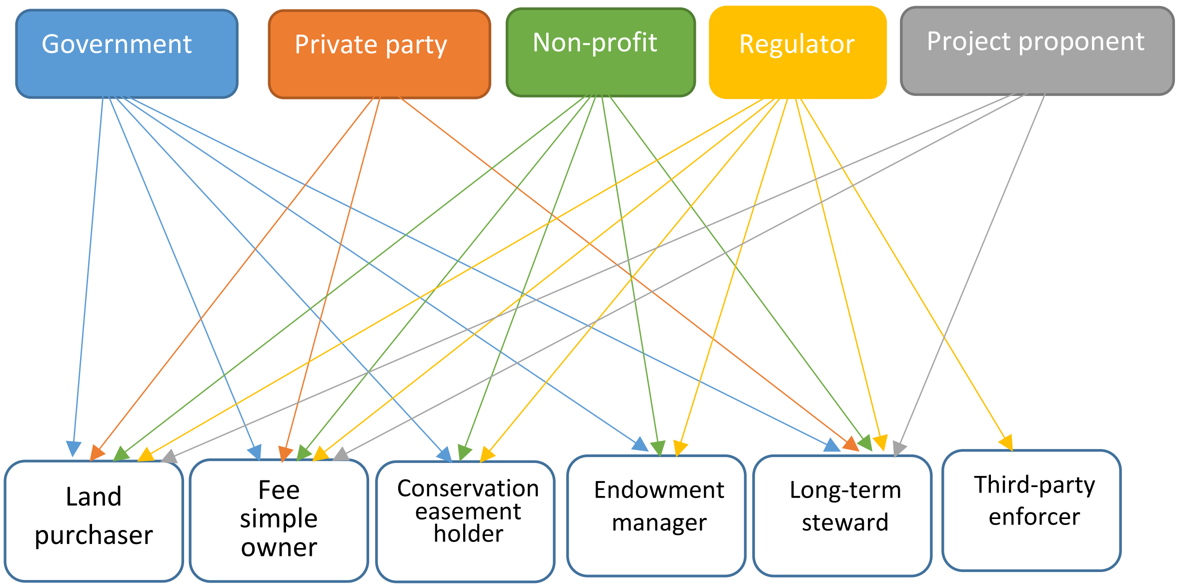


Figure 11. Roles and entities involved in biodiversity banking in the USA.

All different parties and roles are important to make the offset a successful conservation project, with economic and ecological benefits delivering environmental services. However, as seen in the California regulatory banking scheme, natural resource agencies are the primary responsible of BB ecological success as their personnel are primarily trained in natural sciences (Denisoff and DeYoung, 2011). Thus, they become the most powerful party to demand compliance with all the environmental objectives and legal elements set in the BEI. Although there might be the need for more market expertise (Denisoff and DeYoung, 2011), agencies build an interagency review team (IRT) in the setting-up banking process to subdivide duties and provide specific revision of the banks requirements of administrative management (related with short- and long-term assurance), ecological expected performance, and legal issues (i.e. real state assurance as conservation easements). Such subdivision helps the dialogue among all signatory parties to enable the bank through one Banking Enabling Instrument (BEI, is the legal Bank's contract) that will serve as a long term-guideline for agencies and bankers to keep track of the set conservation goals in a determined bank.

Today, a third banking type exists in addition to conservation and mitigation banking in the USA. Hybrid banks delivering mitigation and conservation credits are now common after the USACE 2008 Compensatory Mitigation Rule. This banking supply manner allows species credits to be established in a mitigation bank with CWA section 404 credit types under a multiagency review team (MRT). In such cases the bank need to satisfy the requirements of all different agencies before having the right to sell credits. Usually, the agencies involved are the USFWS with jurisdiction over most of ESA species, NMFS with jurisdiction over listed anadromous fish and marine mammals, the USACE seeking NNL of wetlands, and state agencies with jurisdiction over priority species (endangered or threatened) under state law. The approving process of this kind of banks may become a very complex process since each of the agencies have their guidance on how to set the bank, i.e. how to handle compensation, real state protection and long-term and short-term funding (Layne, 2011). Nevertheless, there should be just one BEI signed by all parties allowing the bank to operate, ideally, as soon as this enabling instrument is agreed by the MRT in less than five years.

Regardless the mechanism used by developers to comply with agencies' requirements for biodiversity compensation, the offset mechanism as BB have two main functions. First, to incentivize behavior encouraging better environmental practices among the developing sector. Second, to fund conservation more cost-efficiently by setting up a market where demand and supply have a common objective for nature. These two main purposes have made US banking proliferate since their positive empirical performance in USA (Madsen et al., 2010; Denisoff, DeYoung, 2011; Madsen et al., 2011 and Bunn et al., 2014a). Also, BB helps developers to comply with their compensation requirements while developing a business model able to generate revenue and achieve long-term conservation.

7.3.2 The developers' power of demand

Developers have a crucial role in the credits market of BB as they are drivers of growth and indicator of economy's situation. Projects seeking to satisfy society's needs, whether necessary or supplementary for a more comfortable and prosperous well-being, must comply with all legal requirements (Maron et al., 2012), going from the construction materials to offsetting the identified and quantified ecological impacts. Consequently, the development becomes a clear sign for bankers of better business, i.e. more likelihood to sell credits in less time. Such scenario implies bankers would know beforehand where development is going to occur. However this information is not available from urban planning authorities (including military and scientific development) to bankers straightforward. In practice, the empirical functioning of US BB shows that developers, authorities and bankers encounter in national meetings where such scenarios are discussed among other issues so that bankers can prioritize the creation of new banks, by future development and conservation needs in the agenda of environmental agencies.

The advantages of such communication among policy makers including agencies, developers and bankers are favorable for not only the BB business and the interested landowners, but most importantly, for the jeopardized environment, ecosystem, their services and functions for the species and society. The direct benefits for bankers are a higher certainty of credits sales, faster return on investment, hence, more likelihood to comply with the ecological and economic performance standards that developers, agencies and society desire.

7.4 Bankers and land trust functions

Banks are required to secure their credits permanence as long as the adverse impact exists as a compromise to achieve ecological equivalence towards NNL (Bull et al., 2013). Per the experience of US BB, one of the key elements to comply with the permanence binding is using long-term financial assurances delivered by non-commercial investment institutions (non-profit), i.e. the land trust. The main land trust function is to manage the endowment and deliver economical resources annually for the bank stewardship. In this way, the banker secures the bank's maintenance in perpetuity, or for as long the conservation/mitigation bank policies require it in the corresponding State of operation. The banker creates a conservation/mitigation endowment held by the land trust to release enough economic resources to maintain, manage and monitor suitable ecology status of the bank annually.

The interest generated by the endowment are delivered from the land-trust to the bank manager with the sole objective to provide financial resources for the bank management. During the planning of a new biodiversity bank, bankers need to consider three key elements needed for the banks approval and survival as mentioned before: 1) management plan, 2) real state protection (conservation easement) and 3) long-term stewardship funding. Thus, the bank agrees with the Interagency Review Team (IRT, the group of agencies signatories of the bank enabling instrument, i.e. the enabling contract) the long-term management actions needed to sustain the habitat and species of interest by anticipating the actions and cost of such perpetual management upfront. This step is extremely challenging, as a successful long-term stewardship is based on an adaptive management and all variable costs associated with the land location, area, habitat type and species. The Property Analysis Record (PAR©), developed by the Center for Natural Lands Management, is one tool widely used among bankers in the USA to facilitate the long-term stewardship and determine the endowment amount needed to generate enough interests.

To secure sufficient funds for long-term management developers rely on the land trust holding non-wasting endowments to generate enough annual interests from their principal capital (usually ranging from 4-5% interest) used only for the bank's stewardship. Currently, the US Fish & Wildlife Service encourages bankers to generate enough annual earnings equal to inflation adjusted ongoing cost out of a non-wasting endowment. This type of endowment does not invade the capital principal but instead reinvest some of the earnings in order to make the endowment principal grow. Hence, there will be earnings thereon that will fund the inflation-adjusted costs of perpetual management and monitoring (Teresa, 2008).

In 2008, the US Congress acted the National Fish and Wildlife Foundation (NSFW) as an official institution of the land trust for biodiversity bankers (for conservation and mitigation). With this, the delivered message to developers was that their project would have better acceptance when their BO is complied with credits purchased from banks contracted to the NSFW. In this manner, bankers and developers are encouraged to move towards more secure credits in the long run that satisfies agency's conservation concern.

7.5 Discrepancies of US biodiversity banking

All BB schemes differ from each other depending on their characteristics, as: (i) be voluntary[42] or mandatory, (ii) involve different authorities and legal frameworks, (iii) follow different conservation priorities related to the land and scale, and (iv) serve public and/or private needs for compensation on commercial and non-commercial basis.

Once the banker succeeded to implement MB or CB, the permanence of offset projects is expected. There are two challenges related to this longevity issue: (i) defining the durability time and (ii) ensuring the ecological values are delivered and sustained through that time (Bull et al., 2013).

[42] For example, those voluntary offsets driven by the PS6 requirements of the International Finance Corporation of the World Bank Group.

The compliance with the permanence concept is key in the US BB. The USFWS[43] (2015) ratifies the scientific understanding that species (federally listed) conservation is a lifetime commitment, and perpetuity should lead to a long-term net benefit. Notwithstanding, some States in the US engage conservation by a limited time allowing conservation easements to expire after some decades. The State of Alabama[44] grants 30 years of validity (NOAA, 2012), Kansas 50 years (USSCNR, 2014) and North Dakota 99 years (USGAO, 2007). Whereas, California, Florida, and Texas keep the perpetuity element. However, perpetuity is uncertain in the case of land-use conversion when easements are not renewed and let the impacts uncompensated.

7.6 The US Conservation banking implementation practicalities and challenges

Conservation Banking (CB) is the oldest known and most studied market-based mechanism addressing impacts over habitats and endangered species. The mechanism has encouraged the creation of lands permanently protected[45] to deliver ES that provide habitat for endangered, threatened and even candidate species to be listed as endangered in the US (USFWS, 2015). The California Conservation Banking implemented in 1995, is the most experienced species compensatory program that has inspired other countries (like Spain and France) to create a similar offsetting scheme due to this program sustainability to be implemented through time.

From a distant view CB seems to be a very good role-model to follow and to imitate as a market-based offsetting scheme due to its achievements related with the business accomplishment of bankers (Madsen et al., 2010; Madsen et al., 2011; Denisoff and DeYoung, 2011), and species and habitats conservation achievements (Denisoff and

[43] USFWS is preparing new guidelines for the conservation banking mechanism. This new policy, "Endangered Species Act Compensation Policy", renews the conservation banking definition to clarify that banks de facto deliver ecological services and functions needed for the enlisted species survival. However, the still valid definition and the anticipated new one, keep the key concept that "*a conservation bank is a parcel of land […] conserved and managed in perpetuity …*" (USFWS, 2003)

[44] Uniform Conservation Easement Act (Ala. Code §§ 35-18-1 through 35-18-2-c)

[45] The definition of "permanently" can change accordingly with the State Conservation Banking Regulations in place, if any, as presented in section 7.2 of this chapter 7.

DeYoung, 2011; USFWS, 2013; Bunn et al., 2014a; Mann and Absher, 2014). But, considering the longevity of the scheme and its constant applicability in the USA in the last decade (Bunn, 2013), researchers and other regulators can now investigate for this scheme' challenges and pitfalls, and for the lessons that can be taught to other countries or regions looking to implement a similar scheme. Bunn et al. (2013) have studied the problems of CB at a State level in California and limited his investigation to just the State approved banks. Their findings demonstrate that there are problems associated to the implementation of CB in California, and that they are related with three main factors: 1) the lack of regulations and clear standards, 2) lack of funding, and 3) inefficiency and ecological limitations to manage a bank (Bunn et al., 2013).

The Conservation Banking program has been implemented across the US since the publication of the "Guidance for the establishment, use and operation of conservation banks", in 2003. Therefore, the challenges and pitfalls of more inexperience American States than California, are also of great value for other nations looking to develop and pilot or implement such a scheme. For this reason, this thesis has extended the research of Bunn et al. to collect the opinion of CB practitioners and regulators of States other than California with the objective of collecting direct information from practitioners and regulators about the considered factors to set and approve a bank, and the pitfalls and/or challenges of the US CB program.

The methods for this investigation are presented in Chapter 3. The following results showed some points of agreement and divergent opinions in the following topics on CB.

Motivations for the establishment of a conservation bank

The most frequent motivation for establishing a conservation bank is to conserve biodiversity and for financial profit activity. 64% of the respondents agreed that those are the most motivating activities for establishing a new bank. In fact, 100% of the responses stated their banks sell the credits to third parties, and 91% responded to represent a private owned bank. 70% of the banks surveyed were created for restoration and enhancement of disturbed habitat, and 75% of the banks represented in this study operate with profit.

Criteria of approval

Bankers and practitioners have different priorities of criteria to select/approve a conservation bank. Agency staff members identified as the most important: 1) habitat and species value, 2) restoration potential and 3) site sustainability. On the other hand, practitioners agreed that the three most important criteria are: 1) habitat and species value, 2) the financial soundness of the bank and 3) the market for its credits. The number 5 and 6 most important criteria for agency members includes markets for credits and financial soundness as for the bankers these criteria are in the top three.

As expected agency members prioritize the biological features of conservation banks, while bank practitioners emphasized the importance of the credits market and financial risks.

Criteria for selecting a receptor site for a CB

For regulators the top three most important criteria to consider when selecting a site as a CB receptor area are: 1) finding sites with habitat and species presence, 2) having the knowledgable agency staff in the program to select the receptor site and, 3) assessing the market for the credits that will be generated. For practitioners, the three most important criteria are: 1) the lack of agency staff to review the proposed site and offer feedback about it, 2) long processing time, administrative burden and uncertainty, and 3) getting the agencies to agree with the proposed site.

Bank practitioners are more concern about the interaction with the agencies approving their proposed site for conservation banks, and the time needed to get approved. Both, agencies and practitioners, agreed that one of the top three criteria for selecting a site is the lack of agency staff dedicated to conservation banking.

Difficult issues to resolve when approving a conservation bank

The top three most difficult issues to resolve for practitioners are very related with the bureaucracy and approval from the agencies: 1) the State and Federal agency time needed for agreement, 2) the total length of the approving process, 3) the considerable bureaucracy related with CB. Whilst, agency staff top three most difficult criteria to resolve for approving a conservation bank is related with: 1) the biodiversity values linked to the site credits, 2) funding the site management, and 3) estimating the site management costs. These three concerns of agencies are very often covered in the new bank proposal and the fact that were indicated as the top three most important criteria shows the agency's concern that the bank will have enough funding to sustain the species.

Barriers for new conservation banks

Considering all the CB program challenges US practitioners and agencies mostly agreed on the top three barriers for new conservation banks. Both, agencies and practitioners agreed that the most important barrier is the approval process being too long. In fact, the majority of the practitioners stated the process last from 2 to 3 years. But in occasions it can go up to 7 years (as indicated in the survey by one respondent). Agency staff second most important barrier is the upfront and management cost, while practitioners are most worried by the lack of market.

The lack of market has been selected as the third most important barrier by agencies, while for practitioners is the lack of dedicated agency staff.

Most important factors to value the bank’s service area to deliver ES and criteria to assess the deliverable credits

Both, agencies and practitioners showed agreement on the three most important factors to assess the bank’s service area and available credits:

1) Species distribution
2) Presence of endangered/threatened species
3) Habitat diversity

Another factor suggested by both groups of respondents was the site’s ecological uplift potential.

Most important factors to value the bank’s credits in monetary terms

For agencies, the most important factors to value the credits in monetary terms generally agree with practitioners. However, practitioners find in the rarity of the credits type an important factor to consider when pricing the credits. In summary, regulators find the following three criteria as the most important: 1) Up-front investment, 2) land-price, 3) management cost. On the other side, practitioners top three is given by: 1) land price, 2) management cost, 3) rarity of credits type.

In conclusion, considering the most important issues and problems to resolve in US Conservation Banking indicated by the participant regulators and practitioners, there is a clear difference in the priorities that agencies and practitioners consider when thinking about selecting and approving a conservation bank. Agencies, as it can be expected, are more inclined to the biology and ecological sustainability of the site than the credits market and time need to approve a bank. Diversely, practitioners consider the financial soundness and economic factors related with the bank sustainability and credits sales as more important criteria to approve a bank.

Besides, both, practitioners and regulators, mostly agreed in the most important challenges in CB. In this investigation, such challenges resulted to be related with the lack of agency staff member knowledgeable about the economic and ecological factors related with CB. As well as the long waiting time that agencies need to approve a bank.

CHAPTER

EIGHT

BREACH BETWEEN THE USA AND EUROPE ON BIODIVERSITY BANKING

In this chapter, the USA and EU regulations for environmental impacts assessment through biodiversity banking are discussed from a crossed-analysis approach. The objective is to give answers to the first and third objective of this thesis on the challenges and limitations of the European efforts towards a BB scheme.

Both, the USA and Europe implemented laws for offsetting in the early 1970s (Table 25). Nonetheless, the norms evolved into different practices to protect the environment. Three main gaps between the US BB and the EU compensation can be identified: (i) the confining different idea of unethical economics instruments concerning ecosystem and biodiversity, (ii) the role of regulations and institutions, and (iii) the strategic planning and use of mitigation hierarchy.

First, the USA and European practices enforcing environmental regulations following different manners to enhance economic growth: financial incentives and market-like solutions Vs. more public-oriented conservation actions. Thus, offsetting in the USA has been more focused on economic incentives evolving from responsible-permittee, in-kind and on-site offset to credits acquisition from private commercial banks. Whereas in Europe financing mechanisms incentivizing private investment on conservation actions, are still debated by policy makers, scientists, environmental groups, and NGOs.

Second, in spite of the European environmental management regulations and institutions, the development and implementation of BB yet need more efforts to enforce *ad hoc* regulations and designate suitable human resources with the responsibility of BB application and compliance. The introduction of conservation easements in the European laws would allow landowners to grant their property right to limit development on their land, for example, a land trust or a government agency. Taxes can motivate such division of property rights so that the landowner can keep the property deed and the grantee can receive the right to use the property for species, and habitat conservation (i.e. wetlands).

Lastly, the vast undeveloped areas of the USA offer more opportunity to plan development along with environmental protection considering the guidance of the ESA and the CWA. The convergence of environmental impacts due to new development and their compensation through BB is possible on a larger scale. Also, thanks to communication strategies policymakers, the private sector and public officials can decide to invest in large scale lands for creating BB in line with significant development agendas. An example is the "Capitol-to-Capitol" annual chamber between Sacramento, CA, and Washington D.C. where private and public sector confront their plans and make business agreements on future projects on topics like transportation, water resources, innovation and technology, development, flood protection, food, and agriculture, etc.

Table 25. Milestones of environmental impacts compensation in USA and Germany, France, Spain, and Italy in Europe

		1970's	**1980's**	**1990's**	**2000's**	**2010's**
Regulatory Events	**USA**	1970. NEPA, the National Environmental Policy Act 1971. CEQA, California Environmental Quality Act 1972. CWA, Clean Water Act (Federal Water Pollution Control Act) 1973. ESA, Endangered Species Act	1982. Inclusion of Habitat Conservation Plans in the ESA (Section 10) 1983. USFWS guidance on MB 1984. 1st Wetland Mitigation Bank 1985. California ESA enforcement	1990. USACE and EPA Memorandum of Agreement 1991. California NCCP approval 1992. 1st single user conservation bank in California, Coles Levee Ecosystem Preserve 1995. California Official Policy on CB 1995. 1st Commercial CB in California, Carlsbad Highland 1995. Federal Guidance on establishment and use and operation of MB	2002. National Mitigation Action Plan 2003. USFWS guidance for establishment, use, and operations of CB 2004. Society of Wetland Scientists positions paper for MB 2007. Water Resources Development Act prefers MB as the offsetting mechanism 2008. EPA and USACE regulations for compensation in hybrid banks	

Regulatory Events				1996. California Department Fish Game and USFWS issued a supplemental policy on CB within the NCCP in Southern California 1996. Consultation promoting the use of CB 1998. Evidence of project-by-project mitigation 1999. USFWS crediting method for vernal pool in California		
	European Union	1979. Wild Birds Directive	1985. Environmental Impact Assessment Dir. (EIAD) (Art. 12 and Art. 16)	1992. Habitat Directive (HD) (Art. 6[3] and Art. 6[4])		2012. Biodiversity No Net Loss Strategy 2014. EIAD amendment
	Germany	1976. Impact Mitigation Regulation (IMR) (Darbi et al., 2009)		1993. Compensation Pools (*Flächenpools*) and Eco-account (*Öko-Konten*) introduction	2002. Nature Conservation Act revision and eco-account for compensation in urban environments (Naumann et al., 2008)	

				resulting from IMR and Federal Building and Spatial Planning (FBSP)		
Regulatory Events	France	1976. Nature Protection Law (NPL, n° 76-629 of July 10th 1976) and the mitigation concept "*séquence ERC*"			2007. Derogations to NPL setting up mitigation and offsets measured when taking of species of 'Community Interest" are consented (Annex IV of Habitat Directive EU) 2008. The launch of the first BB piloting scheme "Biodiversity Offsetting Supply."	2012. Guidelines on the use of the Biodiversity Offsetting Supply scheme.
	England			1999. Environmental Impact Assessment (EIA) in Forestry in England, Scotland and Wales.	2009. Statutory Instruments for Environmental Protection in England	2011. Development of metrics for BB 2012. National Planning Policy Framework 2012. The metric for Biodiversity Offsetting Pilots in England

					2012. Natural Environment White paper publishing a new voluntary approach for BO
Regulatory Events	Spain	1988. Environmental Evaluation Law (EEL)			2013. Amendment of the EEL including a disposition on BB (disposition 8 [4]) as a legal offsetting alternative (BOE, 2013)
	Italy	1988. EIA Law 152		2001. Forest land use change law (D. Lgs. 227/2001) 2006. Amendment of the EIA Law 152	2015 The Senate amended the Environmental Law and its Art. 70 to include Payment for Ecosystem Services as a new form to safeguard the biodiversity.

8.1 Lessons learned from US BB

Biodiversity Banking is the resulting conservation mechanism of evolving policies and their implementation through nearly 30 years in the US. The USA and the European countries addressed in this study have different ecosystems, environmental institutions, and offsetting schemes. Nonetheless, the conducted crossed-analysis allowed us to explore BB from a theoretical and practical point of view. The USA experience on biodiversity offsetting, with its successes and failures, offers a valuable example of what are the policies and institutions needed to develop and implement BB schemes in European countries. The UK, Spain, France, Germany, among other European countries, are making notorious efforts toward market-based instruments to develop BB-like schemes inside and out Natura 2000 sites.

The European Commission interest and policy maker's involvement have shown that there is the will to develop and enforce proper regulations to implement BB for environmental impacts compensation. However, the lack of institutions, especially environmental authorities, and land trusts, and the deficiency of clear guidelines in Europe hinder the enforcement of current compensation policies and obstruct case-by-case compensations. The lessons countries are learning from the BB pilot projects being implemented countries such as England and France help decision makers and practitioners to evolve suitable market-based mechanisms for their country political framework.

The USA has implemented Federal laws and guidelines that are customized for their application at the State and regional scale. On the other hand, the European Union has launched Directives and Strategies needing to be embraced into Country level political framework, and even at a regional scale, to facilitate the development of guidelines and policies suitable to be applied on the ground and used by local agencies and developers. Also, the opportunities and risks of BB need to be balanced before establishing the regulation to frame the future practice. According to the Universal Agreement on Climate Change, signed at the COP21 in Paris in 2015, most of the participating governments prioritize the environmental issues into their political agendas. Consequently, scientist and policy makers expect that market-based mechanism are developed with suitable policies, institutions, and guidelines soon to tackle the loss of ecosystem services and endangered species in Europe.

CHAPTER

NINE

ITALIAN LEGISLATIONS AND EFFORTS TOWARDS BIODIVERSITY BANKING

This chapters deepens into the Italian regulations applied to require compensation of environmental impacts at national level. Then, this chapter analyses the Lombardy's initiative, "Lombardy's Green Fund", towards a BO scheme to study the regulations and current efforts that the country is using on biodiversity offsetting. Finally, an analysis of the Lomardy's Green Fund is made to conclude with a set of recommendations useful to develop a MBI for BO in Italy.

Italy hosts nearly 50% of the plant species and 30% of the animal species of all Europe (ISPRA, 2014). The high urbanization rate and the low compensation actions of such land use changes are causing the decrement of permeable land important for sustaining the biodiversity, hydric retention and other ES (ISPRA, 2014). Today, only the Annex 1 of the Habitat Directive (Art. 6, 4) requires compensation for projects that have significant impacts on Natura 2000 sites. In Italy, the compensation and mitigation are carried out without a considerable positive long-term impact for environmental conservation. Therefore, development of a biodiversity offsetting scheme would introduce a modern solution to tackle the Net Loss of ES in Italy.

Italy embraced the European EIA (in 1988 and amended into the law no. 152/2006) to require compensation for adverse impacts on Natura 2000 sites and forest land[46] (D.Lgs. 227/2001). Nonetheless, there are several issues with the practical application of these laws at the national level (Costantino and Scialò, 2008; Landi 2009; COWI A/S 2009; Bassi et al. 2012). The issues arise with the vague criteria to consider an impact significant enough to comply with compensation measures, especially with impacts on Natura 2000 sites. The problem arises noticeably in more industrialised areas with high population density. Italy reached the forth place of the countries with more land use change in Europe from 1990 to 2000. With nearly 8,400 ha of land consumed in average annually, Italy was above Germany, Spain and France on this list (Pileri, 2007).

Often projects jeopardizing ecosystem values at landscape scale and Natura 2000 sites, limit to propose restoration without aiming at the NNL of the impacts (D. Lgs. 152/2006). Despite the EIA, BD and HD stated preference of possible compensation or offsetting; it is still a common practice to underestimate impacts over Natura 2000 and to not offset permanent and interim unavoidable residual impacts (Bassi, A., et al., 2012), as it has not been made clearly mandatory yet.

[46] In-kind compensation of forestland is mandatory for private projects transforming at least 100 m^2. The threshold is increased to 1000 m^2 in the case of public projects in mountain areas. In both cases, the compensation can only be the afforestation of other lands, according with the art. 4 of the Legislative Decree of May 18 2001 N. 227.

In Italy when protected sites are involved in development projects, it is requested to carry out the EIA, even when the development does not fall into the Annex I of the Directive 2011/92/EU, according to the Annex B of the the D.P.R. (Decree of the President of the Republic) No. 152 published on April 12 1996 (after the first version of the EIA Directive came into force in 1985). The process of assessing the impacts clarifies if the project will have a negative footprint on the environment and, specifically, in the Natura 2000 sites. In some European countries like the UK and Sweden, the mitigation measures in the EIA are a more common implemented practice (Thompson, 2013) in order design and deliver an offset for the impacted ES. In some other countries, including, Italy the EIA and EcIA can be considered just an administrative procedure that the developer has to give compliance with, therefore, EIA and EcIA are not always executed during the planning of the development project and not totally required to deliver offsets.

Also, the forest land and Natura 2000 sites are protected against the land use change (Decree of the legislation, D. Lgs. May 18 2001, no. 227; D.P.R. 12 April, 1996), but the concerns related accumulate because more common lands undergoing change are often underestimated.

In Italy, the compensation for forest land has also been developed. Whenever forest land is subject to LUC, the Legislative Decree of May 18 2001 N. 227 (D.Lgs. 227/2001) according to its Article 4, the occurred forest transformation must be compensated with the reforestation of other areas (D.Lgs 227/2001, 2001).

The forest is one of the land-uses more protected by the civil law, and the environmental and urban jurisdiction in Italy. Thus, all kind of modification and alteration to the forest values of the ecosystem, landscape and historic lands must be authorized by the local authority and regional authority.

9.1 Veneto forest land compensation legislation

Since 1978 the Veneto Region of Italy has adopted its legislation to preserve the forest land. According to this law, forest is all lands covered with arboreal forest vegetation (with or without the shrubby cover) of natural or artificial origin at any development stage covering at least 30% of the land area (L.F.R. September 13, 1978; ARPAV, 2010). Also, lands covered by chestnuts are considered forest, as well as those areas temporarily with no vegetation (or less than the 30% of the canopy) due to natural or human causes, but not the woody crops. (L.F.R. September 13, 1978).

The article 15 of the Veneto's forest regional law prohibits any forest reduction unless the land use change is authorized by the Regional Council and the lost forest functions are compensated trough the following measures: a) create a new forest of at least equal area that the transformed forest, b) improve the forest management of an existent forest of at least two times the area of the modified forest, c) pay to the corresponded regional found the amount equivalent to the average cost of the forest management of b). (L.F.R. September 13, 1978).

9.2 The Lombardy practices in forest land

The Lombardy Region has amended the Forest National Decree into its Regional Forest Law, L.R. 27/2004, following the D.Lgs. 227/2001 in order to introduce the concept of forest compensation. This law states that all the forest interventions eliminating the natural forest vegetation for different purposes are banned and can only be executed with the authorization of the regional authority, the mountain community and the parks and reserves managers, in order to conserve the biodiversity, the terrain stability, the water regime, the flood prevention and the landscape protection.

The L.R. 27/2004 was first included in the Regional Decree (D.G.R.) 13900/2003 where the threshold of 100 m^2 (1000 m^2 in the case the forest land were needed for a public project in mountain areas) was considered to be the smallest area of forest transformation subject to compensation. The choice of this threshold is subject to debate because the fragmentation of the forest due to the loss of smaller deforestation but with higher occurrence can be still a source of forest transformation.

In 2006 the D.G.R. 13900/2003 was amended including three new exceptions:

1) The forest compensation will be required only for forest land transformation over 2000 m^2 (included in protected areas) when the land is needed for:

a. Useful public projects;

b. Construction of roads with forest and cattle feeding purposes.

2) The compensation for deforestation over 500 m^2 will be required only for:

a. Projects aiming to connect existing building with roads or other technological forms of transport;

b. Projects to enlarge existing buildings used for the agriculture located inland categorized for the agro-forestry use (category E) according to the L. 765/1967.

3) The compensation will be required for the transformation of the land larger than 20000 m^2 when these are planned to be transformed with the following objectives:

a. Elimination of abandoned agricultural land of up to 30 years old with presence of shrubs and trees species;

b. Recovery of agricultural land, to be used for agricultural purposes in the same location for ar least 20 years without any kind of construction involved;

c. Construction of agro-forestry areas categorized "E" by the L. 765/1967;

d. The transformation is executed in Mountain areas classified according to the D.G.R. 10443 (September 30, 2002), or in areas classified as "hills" by the ISTAT where there is an elevated forest area index.

Following the previous guidelines the developer must compensate the transformation of forest land with the reforestation of other lands according to the Forest Law L.R. 27/2004 Article 4,4 subsection b that states that the compensation must be executed in non-forested land that is two times larger that the transformed land (ratio 1:2) whenever the transformation be carried out in areas with forest cover less than the 15%. This means that for the transformation of 1 m^2 of land 2 m^2 must be reforested (Pileri, 2007).

9.3 Lombardy's Green Fund

The Lombardy's Green Fund (*Fondo Verde di Lombardia*) is an Italian scheme for the environmental compensation of agricultural-land-use transformation into developed land, i.e. paved land. The fund was enforced in 2009 in all the municipalities of Lombardy's Region to collect a monetary contribution from the development projects occurring in the territory. The contribution is an in-lieu fee collected into a financial account funded by the developers and hold by the Financial Department of Lombardy's Region to compensate for their environmental impacts on agricultural land. Developers pay a fee that ranges from 1.5% to 5% of the development's project total cost (Figure 12). All, small and big projects causing the LUC of agricultural land are required to pay this in lieu fee. The money is collected by each municipality and then deposited in the Regional Fund. The money is then used to finance environmental enhancement and creation projects in the same municipality where the LUC. The money allocated to each environmental intervention is equivalent to the money deposited corresponding to one particular project. In this way, each project causing the LUC of agricultural land in a particular municipality funds an environmental enhancement in that same political area in a project-to-compensation basis. However, the project-to-compensation system can be enlarged to more comprehensive projects to deliver better environmental enhancement on the ground when small developments have made a small contributions, and better results can be delivered by summing up efforts instead of individualising into a project-to-compensation singular case.

Since the date the developer delivers the fee to the Green Fund, the municipality has three years to design and execute the enhancement on the law. To further have a higher impact on the Lomardy's ecosystems, the Region allocates the money to co-fund the ecological interventions in the framework of larger projects co-funded too by the European Union, as the LIFE[47] projects. Therefore, the first environmental enhacement on the land were registered in 2011 after three years of the fund started. The common project include the stewarship of swamps, water courses, natural hedges and shrubs, the enhacement of grasslands with target species.

The Lombardy's Green Fund model has collected up to July 2016, 6 millions Euros of which it has invested nearly just 18% in 63 projects covering a surface of 77.30 ha, divided into mainly 5 ha of linear natural hedges, 16 ha of forest, 38 ha of silvicultural enhancement practices, 8 ha of other natural improvements (MFAV, 2016). From the moments the environmental improvemet corred the scheme considers two years of management actions to make support better ecological results. The Plan of Ecological Network and the Forest Regional Plan of Lombardy offers a guideline to communities to know where to place the fund money to allocate the offsets.

Overall the Lombardy's Green Fund is a good example of how to fund environmental management and improvements from projects that have a negative impact on the environment without conflicting with the Natura 2000 sites network, and the related European regulatiosn that overlook and require the compensations for impacts over such valuable ecological sites. A separate fund like the Green Fund can become a powerful tool for directing efforts towards the creation of a NNL scheme offsetting impacts over agricultural and other type of non protected habitats. The limitations that this scheme is encountering are: 1) the difficulty to find recepting areas, and 2) the lack of monitoring and assessing of the delivered ES after the land has been managed. Learning form the Lombardy's green fund experienece Italy can

[47] LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. Since 1992, LIFE has co-financed some 4306 projects for the protection of the environment and climate.

think of extending such scheme or to lean toward a MBI for BO and incorporate new regulations to fund activities to conserve the Italian biodiversity.

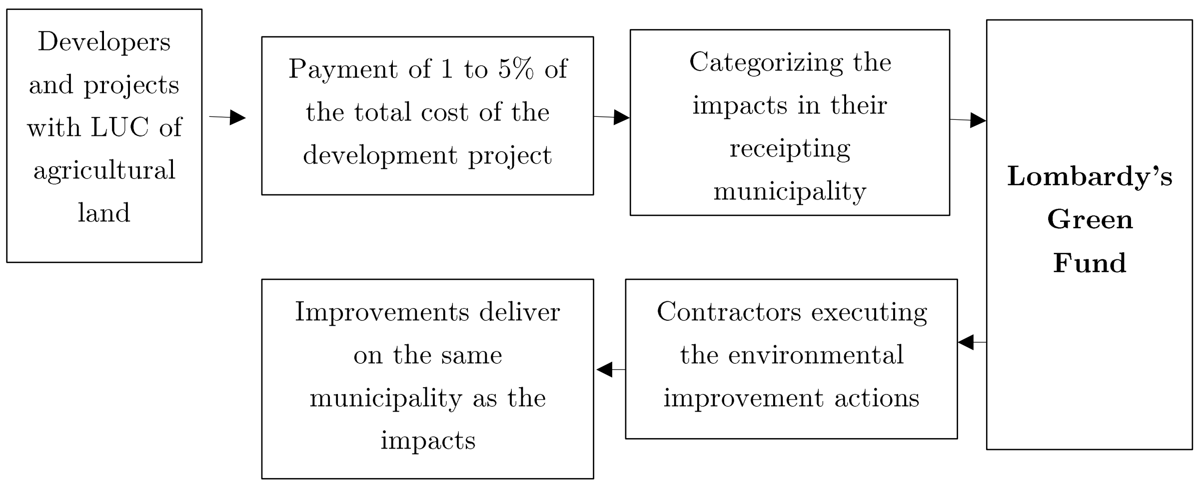


Figure 12. Green Fund graphical representation of the in-lieu fee program.

9.4 Italian existing compensation methods and potential for change: towards a MBI for BO

Italy has three types of compensation schemes working. The compensation of forest land, compensation of impacts on Natura 2000 sites and the compensation of LUC of agricultural land applicable in Lombardy's Region. The compensation of forest land is a permittee-responsible compensation type of scheme executed on a case-by-case basis and regulated by the Municipality where the impact happened. The impacts on Natura 2000 sites are also permittee-responsible compensations, meaning that the developer executes the EIA and EcIA to identify and divide the impacts into permanent or temporary and carry out the mitigation for such impacts according with the requirements of the local authority. Finally, the compensation of the LUC of agricultural land, i.e. the Green Fund Model of Lombardy. The Green Fund is an in lieu fee program where the money is collected by the Communities and allocated in a regional fund financing the enhancement, creating or protection of important environmental sites delivering compensation of development projects.

The common features of these three existing compensation methods are that all are regulated by the legislation, occurred ex-post of the development project and are rarely monitored and/or long-term financed to ensured permanence after their environmental services delivery.

The Lombardy's Green Fund is an in lieu fee program launched in 2009 used to compensate for the LUC of agricultural land due to development projects. The fund is a BO mechanism that has shown some difficulties to be applied due to the limitation of authorities capacities at the Community's level to plan and develop the compensation actions. The Green Fund finances compensation in a case-by-case basis to offsets ex-post and off-site the environmental impacts due the LUC of agricultural areas. The lack of guidelines to know how to choose a suitable compensation for each project, i.e. location and extension of the offset, and the lack of the small local authorities capacity to implement the environmental enhancement projects are making that the Lombardy's Green Fund gets limited results on the land in terms of ecological value (ES delivery, species occurrence) of the produced offsets.

Nonetheless Lombardy's Green Fund limitations, it is a very valuable empirical example of BO applicability in the form of an in-lieu fee program. It helps to raise funds to be invested in the enhancement, creation, or protection of valuable ecological zones. Such scheme can become the first step into developing a MBI for BO. Understanding the Fund dynamic and building capacities at the regulators level will serve to be able to develop a legislation capable of sustaining a MBI where the supply side (landowners) can meet with the demand side (developers in need of compensation) to offsets unavoidable residual impacts of LUC related with the execution of development projects.

The development of a MBI for the LUC of agricultural land and other important habitats that are not designated protected sites (Natura 2000 areas), would allow to finance the creation of habitats of significant ecological value. The issues that such scheme can encounter are related to the fundamental features of the US BB:

1) **Short-term funding** for creating, enhancing or protecting the site and make all necessary management to set the offset and deliver ES. In the USA, the offsets are often provided by stable Biodiversity Banking Companies that invest in advanced mitigation by acquiring the land (or the proterty rights of a land) to create a conservation bank. The conservation bank would be located on an area with the aimed specific type of habitat and species. The company or companies investing on the advanced mitigation, i.e. conservation banks, are able to finance such business with the cash flow of other connected business, as it can be real state trade activity or other financing shares from development companies. In Italy, the capital can be raised stabilizing an in lieu fee programs like the Lombardy's Fund to finance the creatin of offsets. This would need a regulatory agency requiring developers to pay their contribution to offsets their impacts on the caused LUC. Italy could standardize such requirements like Lombardy's Region and collect the money in a specific fund to be used for offsite and ex-post compensation of development projects. The difference between the US BB program and this hypothetical Italian program would be that the mitigation is not in advance and so the discounting factor would become important to consider the time needed to have the expected ES on the environment.

2) **Real state assurance** is given by land trusts agencies that keep the conservation easement to protect the receptive offsetting area from changing land-use in future. Such assurance can be obtained in Italy by the creating a contract with the landowners to assure it will me managed and used, as long as possible and

accepted by the regulators, for the conservation of biodiversity according to a set plan of management to maintain the ES in the long term.

3) **Long-term management** and land protection assurance. The American conservation easements and the existance of land trusts to hold those easements aim to the long-term mantainance of the offset receptor site. The long-term management is possible by disposing of a certain quantity of money to the management of the site in perpetuity or as far as regulations requires it. In the USA non-expendable endowments are funded to provide sufficient resources to manage the land annually. In Italy, a similar scheme for annual funding can be obtained with Green Investment Funds working like a collective bank account. Differently from the non-expendable funds the investment funds can be funded by diverse parties and, generally, increase their main principal to give a determined percentage of interest that can be used to cover the long-term management costs.

Part III

CONCLUSIONS

Conclusions

There is no doubt that Biodiversity Offsets are a useful and effective tool to regulate and deliver compensation for the unavoidable residual environmental impacts related to the land-use change of development projects. The diversity of regulatory schemes types and the variety of metrics that can be implemented to assess and offset such environmental impacts accommodate to the different governmental regulations, geographical regions and the practitioners of a certain region or country. Biodiversity offsetting in its three main forms, i.e. permittee-responsible (project-by-project compensations), in-lieu fee (compensation payments) and biodiversity banking (trade of compensation credits created off-site to provide like-for-like compensation in advance of the impacts), are widely applied in the USA to compensate for environmental impacts, and are also applied in Europe. However, greater efforts are needed to tackle the alarming rate of habitats and ecosystem services loss in Europe.

The Biodiversity Strategy and the No Net Loss (NNL) Strategies are an invitation for the Members States to develop more cost and ecologically effective manners to protect and conserve European ecosystems, their habitats, delivered ecosystem services and species of special interest. In this sense, this thesis looked to investigate from an institutional, regulatory and empirical point of view the use of the Market-Based Instruments (MBI), Biodiversity Banking, to address the loss of ecosystem services in Europe, and to provide a scientific framework for policies and impacts assessment tools to facilitate policy makers the development of MBI to compensate for environmental impacts, in Europe and in Italy. This thesis studied from a regulatory and ecological view the assessment methods of environmental impacts and investigated from a political point of view the policies and regulations implemented in Europe and the USA to deliver compensation of environmental impacts.

The metrics investigated in this thesis to account for the environmental impacts, and its applicability to the Italian ecosystems, provides an influential scientific framework for the development and employment of a metrics to the current compensations, and future development of MBIs. The customization of the DEFRA Offsetting Methodology to the Italian ecosystems, and its empirical application to the High-Speed Road *Pedemontana Veneta* case-study, exemplifies in detail the ecological and site-specific factors to consider in biodiversity offsetting. Both offsetting project options analyzed for the *Superstrada Pedemontana Veneta* case study illustrate the potential that a market-base mechanism can have to compensate for the environmental impacts of development projects, as it could become an important source of funding to manage buffering areas of priority habitats, and deliver payment for ecosystem services to private landowners. Therefore, the tailored metrics developed in this study provides a powerful tool for policy makers and researchers to consider the ecological and economic features of compensation on the ground. This metrics give a pragmatic model to assess the residual environmental impacts of development projects and offers a replicable methodology to propose offsets that, only after the development mitigation hierarchy consideration, would contribute to no net loss of biodiversity in Italy and Europe.

The European Habitats, Wild Birds, and the Environmental Impact Assessment Directives play an important role in conserving the habitats and species of the Natura 2000 network of protected areas. However, there is still an opportunity for improvements and conserve important areas in addition to the Natura 2000 network, and aim at the NNL of ecosystem services including biodiversity of all types of habitats subject to land-use change (LUC) due to development projects. The unavoidable residual impacts of development projects are a source of net environmental loss, and such effects need to be addressed in Europe in addition to the compensations related to Natura 2000 sites. This thesis studied the countries of Germany, France, Spain, Italy and the UK, and their initiatives on developing MBI like Biodiversity Banking (BB) to offsets for the land-use change related to development projects, also, outside Natura 2000 sites. This thesis showed that the common limitation of these countries' MBI initiatives is the need of more developed guidelines and policies to regulate and create a demand of offsetting from the governmental agencies side. For example, the case of the UK Habitat Banking pilot projects of DEFRA had limited results on helping to initiate a BB scheme. The government's loss of interest in creating a policy to require environmental offsetting of development projects impacting outside protected sites, have delayed and hindered the development and application of an innovative MBI for funding new forms of environmental conservation through biodiversity offsetting. Despite the UK policies limitation for a BB, there are voluntary forms of compensation occurring in England because of the revealed interest of private companies and some Local Planning Authorities.

Moreover, the efforts of Germany to offer compensation for the agency's' projects show that a non-market based scheme, but a regulated government-driven compensation mechanism, would also help tackle the loss of ecosystem services on the ground by creating conservation sites that provide compensations for development projects. This bundle of single-user offsets located in one selected natural conservation site, accounts for the compensation of state and regional agency's projects while being also an innovative way to tackle the loss of ecosystem services due to LUC.

The studied case of the USA Conservation (species) and Mitigation (wetlands) Banking Scheme, from the interviewed practitioners and regulators point of view, showed that there are key factors to consider when developing, implementing and utilizing biodiversity offsets schemes: 1) the clear and standardized regulations and guidelines to require offsets of development projects, i.e. the demand side creation, and hence, the creation of incentives for the supply side to create habitat banks. The designation of a sufficient and knowledgeable number of agency staff is needed for the development, implementation, monitoring and auditing of the occurred offsets. 2) The MBI profitability assurance, i.e. the income generation of landowners (or bigger practitioners like the American conservation banking companies) to incentivize the creation of conservation areas generating habitat credits to compensate in advance of the impacts. And 3) clear guidelines and regulations for the creation and maintenance of the conservation banks to supply with good quality ecological habitat credits. Time longevity, environmental standards accomplishment and long-term financial funding should be addressed in such guidelines to assure that the ecosystem services and goods are managed and have a meaningful time of permanence.

The Italian environmental offsets are occurring under the Habitat, Wild birds and EIA Directives, and the currently enforced Regional Forest Laws. However, further efforts are needed to fund conservation measures of important habitats outside the Natura 200 network. The Lombardy's Green Fund is an excellent example of an innovative initiative to finance the execution of environmental conservation, creation and natural enhancement activities. The limitations that the Green Fund is encountering are related with: 1) the difficulty to find recepting areas, and 2) the lack of monitoring and assessing of the delivered ES after the land has been managed. These challenges relate with some difficultiesof showed by the USA Conservation Banking scheme according with this investigation, and can be due to the lack of dedicated staff members. Nonethess

Lombardy's Green Fund limitations, it is a very valuable empirical example of the applicability and functioning of BO, in this case in the form of an in-lieu fee program.

Learning from the Lombardy's Green Fund experience can become the first step into developing a MBI for BO in Italy. Understanding the Fund's dynamic and building capacities at the regulators level will serve on the development of legislation for a MBI, where the supply side (landowners) can meet with the demand side (developers in need of compensation) to offsets unavoidable residual impacts of LUC related with development projects. The lessons learned from the USA banking schemes also serve as a model for Italy to build a system that would consider potential upcoming challenges, and resolve essential issues that any MBI will encounter and are related to the three key elements of the USA MBI for BO, short-term funding, the real state assurance, and long-term management.

Italy hosts an extensive variety of European protected plants and species, and unique Mediterranean ecosystems, the embracement of a widespread biodiversity offsetting scheme would help enormously the protection and management of decayed natural areas. This thesis offers the scientific background and key information essential for the development and employment of a biodiversity offsetting scheme warding our ecosystems and habitats and their provision of services. Weather it will be the form of a voluntary or mandatory scheme, the allocation of efforts and resources to learn from the own experience on piloting a MBI would help practitioners and policy makers to perceive the great potential that such instruments have to protect the environment.

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Annex 1

Distinctiveness values for all Italian habitat types

This annex presents some of the habitat types in the Italian territory according to their codification in CORINE biotope (Table A in Italian) and the European Union Habitat Code (EUR28) of the protected habitats. The habitats listed here presented represent the range of habitat distinctiveness values according with the habitat type. This is a proposal of how to categorize the Italian habitats and use the values alongside the Metrics Proposal for Developing a Biodiversity Offsetting Scheme in Italy.

This document bases on the table of codification matching elaborated by the Italian Institute for Environmental Protection and Research, ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) in 2013, available at http://www.isprambiente.gov.it/it/temi/biodiversita/lispra-e-la-biodiversita/attivita-e-progetti/elenchi-degli-habitat-italiani

The proposed rule for assigning the distinctiveness value of a habitat type in this thesis is to divide the developed land into the habitat types and scored according to the distinctiveness value given in the Table A following the reasoning explained in the Chapter 6 (section 6.1.1 Habitat distinctiveness).

NOTE: The full list of habitat types and their codification can be consulted in the electronic version of this thesis by double clicking on the following icon.

ANNEX
1_Distictiveness_Itali

Table A. Habitat distinctiveness according to the Italian habitat type of the CORINE BIOTOPE CODE

Code of the Interpretation Manual of European Union Habitats - EUR28	Interpretation Manual of European Union Habitats - EUR28	Priority	CORINE Biotopes Codes	CORINE Diotopes definition	EUNIS Code	EUNIS definition	Distictiveness
			1	Habitat litoranei ed alofili	A	Habitat marini	3
			1	Habitat litoranei ed alofili	B	Habitat costieri	3
			2	Acque non marine	C	Ambienti acquatici dell'entroterra	3
			3	Cespuglieti e praterie	F	Habitat cespugliati, brughiere e comunità della tundra	3
					E	Prati e consorzi di alte erbe dominate da piante vascolari, muschi e licheni	3
			4	Foreste	G	Foreste, boschi ed altri habitat alberati	3
			5	Torbiere e paludi	D	Torbiere e paludi	3
			6	Rupi Ghiaioni e Sabbie	H	Habitat dell'entroterra	3

				con vegetazione assente o rada	
	8	Coltivi ed Aree costruite	I	Habitat rurali e domestici, con coltivazioni agricole ed orto-frutticole, attive o recenti	2
	11	Mari e oceani	A	Habitat marini	3
	11.1	Acque marine	A7	Colonna d'acqua pelagica	3
	11.1	Acque marine	A7.8	Colonna d'acqua non stratificata con piena salinità	3
	11.12	Acque di piattaforma e scarpata	A7.82	Zona mesopelagica in masse d’acqua non stratificata e a salinità normale	3
	11.121	Acque costiere	A7.82	Zona mesopelagica in masse d’acqua non stratificata e a salinità normale	3
	11.122	Acque di mare aperto	A7.82	Zona mesopelagica in masse d’acqua non stratificata e a salinità normale	3
	11.123	Scarpata continentale	A7.82	Zona mesopelagica in	3

					masse d'acqua non stratificata e a salinità normale	
		11.124	Acque di risalita (upwellings)	A7.82	Zona mesopelagica in masse d'acqua non stratificata e a salinità normale	3
1110	Banchi di sabbia a debole copertura permanente di acqua marina	11.125	Secche	A7.82	Zona mesopelagica in masse d'acqua non stratificata e a salinità normale	4
		11.2	Benthos (Fondi marini)	A6	Fondi marini profondi	3
		11.21	Fondi marini profondi	A6	Fondi marini profondi	3
1110	Banchi di sabbia a debole copertura permanente di acqua marina	11.22	Fondi marini sublitorali soffici	A5	Sedimenti sublitoranei	4
1130	Estuari	11.22	Fondi marini sublitorali soffici	A5	Sedimenti sublitoranei	4

		11.23	Fondi marini sublitorali ghiaiosi	A5	Sedimenti sublitoranei	3
1170	Scogliere	11.24	Fondi rocciosi del sublitorale	A3	Rocce infralitorali ed altri substrati duri	4
1170	Scogliere	11.24	Fondi rocciosi del sublitorale	A4	Rocce circalitorali ed altri substrati duri	4
		11.4	Vegetazione delle acque marine salmastre	A5.54	Comunità di angiosperme in acque (marine) a salinità ridotta	3
		11.41	Aggruppamenti a *Ruppia marittima*	A5.534	Comunità a Ruppia e Zannichellia	3
		11.42	Banchi di *Eleocharis*	A2.621	Letti ad *Eleocharis*	3
		12	Bracci di mare (baie e canali)	A3	Rocce sublitoranee e ad altri substrati duri	3
1160	Grandi cale e baie poco profonde	11.24	Fondi rocciosi del sublitorale	A4.1	Rocce circalitorali Atlantiche e Mediterranee ad alta energia	4
1160	Grandi cale e baie poco profonde	11.24	Fondi rocciosi del sublitorale	A3.1	Rocce infralitorali ad alta energia dell'Atlantico e del Mediterraneo	4

1310	Vegetazione annua pioniera a *Salicornia* e altre specie delle zone fangose e sabbiose	15.1	Praterie salate pioniere	A2.55	Comunità di piante pioniere delle paludi salse	4
1320	Prati di Spartina (Spartinion maritimae)	15.2	Praterie a *Spartina*	A2.55	Comunità di piante pioniere delle paludi salse	4
1340	Pascoli inondati continentali (Puccinellietalia distantis)	15.4	Prati salati continentali	D6.1	Paludi salse dell'entroterra	4
1410	Pascoli inondati mediterranei (Juncetalia maritimi)	15.5	Vegetazione delle paludi salmastre mediterranee	A2.51	Linee di deposito delle paludi salate	4
1410	Pascoli inondati mediterranei (Juncetalia maritimi)	15.5	Vegetazione delle paludi salmastre mediterranee	A2.52	Paludi salse del litorale superiore	4
		16.12	Comunità delle linee di deposito delle spiaggie sabbiose	B1.131	Comunità annuali delle spiaggie sabbiose del Mediterraneo occidentale	3
		16.2	Dune	B1	Dune costiere ed altri habitat sabbiosi marittimi	3

			16.21	Dune mobili e dune bianche	B1.31	Dune mobili embrionali	3
2110	Dune mobili embrionali		16.211	Dune mobili	B1.31	Dune mobili embrionali	4
2130	Dune costiere fisse a vegetazione erbacea ("dune grigie")	Prioritario	16.223	Dune grigie mediterraneo-Atlantiche	B1.43	Dune costiere stabili del Mediterraneo centrale e occidentale e delle coste termo-atlantiche del sud-Iberia e nord-Africa	4
2210	Dune fisse del litorale del Crucianellion maritimae		16.223	Dune grigie mediterraneo-Atlantiche	B1.43	Dune costiere stabili del Mediterraneo centrale e occidentale e delle coste termo-atlantiche del sud-Iberia e nord-Africa	4
2210	Dune fisse del litorale del Crucianellion maritimae		16.227	Comunità dunali a specie annuali	B1.47	Comunità dunali di terofite graminiformi pioniere su suolo superficiale	4
			18	Rupi marittime e coste rocciose	B3.2	Habitat rocciosi costieri (scogliere, spiagge ed	3

					isolette) privi di vegetazione	
		18.1	Scogliere nude	B3.2	Habitat rocciosi costieri (scogliere, spiagge ed isolette) privi di vegetazione	3
		18.1	Scogliere nude	B3.26	Scogliere e coste rocciose mediterraneo-pontiche	3
		18.17	Comunità sopralitoranee delle pozze rocciose	A1.42	Comunità sopralitoranee delle pozze rocciose	3
		18.2	Litorali rocciosi e rupi marittime con vegetazione	B3.3	Habitat rocciosi (scogliere, spiagge ed isolette) con vegetazione alofila	3
		18.22	Scogliere e rupi marittime mediterranee	B3.33	Comunità degli habitat rocciosi mediterraneo-atlantici e del Mar Nero	3
1240	Scogliere con vegetazione delle coste mediterranee con	18.22	Scogliere e rupi marittime mediterranee	B3.331	Comunità degli habitat rocciosi mediterraneo-	4

	Limonium spp. endemici					atlantici e del Mar Nero	
1150	Lagune costiere	Prioritario	11.24	Fondi rocciosi del sublitorale	A3.3	Rocce infralitorali del Mediterraneo e dell'Atlantico a bassa energia	4
			22.1	Acque ferme	C1.3	Laghi, pozze e stagni eutrofici permanenti	3
3110	Acque oligotrofe a bassissimo contenuto minerale delle pianure sabbiose (Littorelletalia uniflorae)		22.11	Acque oligotrofiche povere di calcare	C1.1	Laghi, pozze e stagni oligotrofici permanenti	4
3120	Acque oligotrofe a bassissimo contenuto minerale su terreni generalmente sabbiosi del Mediterraneo occidentale con Isoetes spp.		22.11	Acque oligotrofiche povere di calcare	C1.1	Laghi, pozze e stagni oligotrofici permanenti	4
3140	Acque oligomesotrofe calcaree con		22.12	Acque mesotrofiche	C1.2	Laghi, pozze e stagni mesotrofici	4

	vegetazione bentica di *Chara* spp.					
3130	Acque stagnanti, da oligotrofe a mesotrofe, con vegetazione dei *Littorelletea uniflorae* e/o degli *Isoeto-Nanojuncetea*	22.12	Acque mesotrofiche	C1.2	Laghi, pozze e stagni mesotrofici	4
3150	Laghi eutrofici naturali con vegetazione del Magnopotamion o Hydrocharition	22.13	Acque eutrofiche	C1.3	Laghi, pozze e stagni eutrofici permanenti	4
3160	Laghi e stagni distrofici naturali	22.14	Acque distrofiche	C1.4	Laghi, pozze e stagni distrofici permanenti	4
3110	Acque oligotrofe a bassissimo contenuto minerale delle pianure sabbiose (*Littorelletalia uniflorae*)	22.311	Prati di *Littorella*, stagni a *Lobelia*, pratelli a *Isoëtes*	C3.411	Prati di *Littorella*, stagni a *Lobelia*, pratelli a *Isoëtes*	4

3130	Acque stagnanti, da oligotrofe a mesotrofe, con vegetazione dei Littorelletea uniflorae e/o degli Isoeto-Nanojuncetea	22.311	Prati di *Littorella*, stagni a *Lobelia*, pratelli a *Isoëtes*	C3.411	Prati di *Littorella*, stagni a *Lobelia*, pratelli a *Isoëtes*	4
3130	Acque stagnanti, da oligotrofe a mesotrofe, con vegetazione dei Littorelletea uniflorae e/o degli Isoeto-Nanojuncetea	22.312	Comunità erbacee a *Eleocharis* in acque poco profonde	C3.412	Comunità erbacee a *Eleocharis* in acque poco profonde	4
3110	Acque oligotrofe a bassissimo contenuto minerale delle pianure sabbiose (*Littorelletalia uniflorae*)	22.313	Comunità erbacee delle rive di stagni acidi in acque poco profonde	C3.413	Comunità erbacee delle rive di stagni acidi in acque poco profonde	4
		23.212	Comunità lagunari di vegetazione marina	C1.5212	Comunità sommerse di macrofite in acque saline e salmastre dell'entroterra	3

	23.2	Acque salate e salmastre con vegetazione vascolare	C1.523	Vegetazione flottante delle acque salmastre	3
	24	Acque correnti	C2	Acque correnti di superficie	3
	24.1	Corsi fluviali	C2.1	Sorgenti, fontanili e geyser	3
	24.1	Corsi fluviali	C2.2	Corsi d’acqua permanenti a carattere torrentizio (ruscelli e torrenti), non influenzati dalle maree	3
	24.1	Corsi fluviali	C2.3	Corsi d’acqua permanenti a carattere potamale (fiumi a lento decorso), non influenzati dalle maree	3
	54.11	Sorgenti povere in basi	C2.11	Sorgenti oligominerali	3
	24.11	Ruscelli	C2.16	Ruscelli sorgentizi (crenal)	3
	24.12	Fascia della trota	C2.21	Corsi d'acqua (Epirhitral e metarhitral)	3

		24.13	Fascia del temolo	C2.22	Corsi d'acqua (Hyporhithral)	3
		24.14	Fascia del barbo	C2.31	Corsi d'acqua (Epipotamal)	3
		24.15	Fascia della carpa	C2.32	Corsi d'acqua (Metapotamal and hypopotamal)	3
3290	Fiumi mediterranei a flusso intermittente con il Paspalo-Agrostidion	24.16	Corsi d'acqua intermittenti	C2.5	Corsi d'acqua temporanei (fase umida)	4
				C2.24	Cascate	3
		24.2	Banchi fluviali di ghiaia	C3	Zona litoranea dei corpi idrici dell'interno	3
		24.21	Greti ghiaiosi privi di vegetazione	C3.62	Banchi fluviali di ghiaia privi di vegetazione	3
		24.22	Greti ghiaiosi fluviali con vegetazione	F9.1	Cespuglieti fluviali e lacustri di *Salix* sp.	3
3220	Fiumi alpini e loro vegetazione riparia erbacea	24.221	Greti ghiaiosi dei torrenti subalpini con Epilobium	C3.551	Sponde ghiaiose di ruscelli e torrenti boreo-alpini	4
3220	Fiumi alpini e loro vegetazione riparia erbacea	24.222	Comunità alpine dei greti ghiaiosi	C3.551	Sponde ghiaiose di ruscelli e	4

					torrenti boreo-alpini	
3230	Fiumi alpini con vegetazione riparia legnosa a *Myricaria germanica*	24.223	Cespuglieti a Salici e Myricaria	F9.13	Cespuglieti fluviali montani su suolo ghiaioso	4
3240	Fiumi alpini con vegetazione riparia legnosa a *Salix elaeagnos*	24.224	Cespuglieti e boscaglie dei banchi di ghiaia	F9.14	Cespuglieti e boscaglie dei banchi di ghiaia	4
3250	Fiumi mediterranei a flusso permanente con *Glaucium flavum*	24.225	Greti ghiaiosi mediterranei	C3.553	Habitat delle ghiaiose di fiumi mediterranei	4
		24.226	Ghiaie fluviali di bassa quota	C3.554	Comunità settentrionali delle ghiaie dei fiumi planiziali	3
		24.3	Sponde sabbiose dei fiumi	C3.6	Rive fluviali o lacustri non vegetate con sedimenti fini o mobili	3
		24.4	Vegetazione fluviale sommersa	C2.1	Sorgenti, fontanili e geyser	3

		24.4	Vegetazione fluviale sommersa	C2.2	Corsi d'acqua permanenti a carattere torrentizio (ruscelli e torrenti), non influenzati dalle maree	3
3260	Fiumi delle pianure e montani con vegetazione del Ranunculion fluitantis e Callitricho-Batrachion	24.41	Vegetazione acidofila dei fiumi oligotrofi	C2.18	Vegetazione acidofila dei ruscelli sorgivi oligotrofici	4
		24.5	Banchi fluviali di fango	C3.5	Vegetazione pioniera effimera delle sponde periodicamente sommerse	3
		24.5	Banchi fluviali di fango	C3.6	Rive fluviali non vegetate con sedimenti ripariali fini o mobili	3
		24.5	Banchi fluviali di fango	E5.4	Megaforbieti mesofili e bordure di felci, su suolo umido	3

		24.51	Sponde fangose prive di vegetazione	C3.63	Sponde fluviali fangose prive di vegetazione	3
3270	Fiumi con argini melmosi con vegetazione del Chenopodion rubri p.p. e Bidention p.p.	24.52	Banchi di fango fluviali con vegetazione a carattere eurosiberiano	C3.53	Comunità euro-sibiriche di piante annuali delle sponde fluviali fangose	4
3280	Fiumi mediterranei a flusso permanente con il Paspalo-Agrostidion e con filari ripari di Salix e Populus alba	24.53	Banchi di fango fluviali con vegetazione a carattere mediterraneo	E5.44	Praterie mediterranee di aree fluviali alluvionali	4
3290	Fiumi mediterranei a flusso intermittente con il Paspalo-Agrostidion	24.53	Banchi di fango fluviali con vegetazione a carattere mediterraneo	E5.44	Praterie mediterranee di aree fluviali alluvionali	4
		31	Brughiere e cespuglieti	F2	Arbusteti artici, alpini e subalpini	3
		31	Brughiere e cespuglieti	F7	Lande spinose mediterranee (phrygane,	3

					arbusteti spinosi e vegetazione correlata delle rupi costiere)	
		31	Brughiere e cespuglieti	E5	Consorzi di alte erbe e comunità prative delle radure e dei margini forestali	3
		31	Brughiere e cespuglieti	G5	Filari arborei, piccoli boschetti antropogenici, zone recentemente disboscate, primi stadi di riforestazione e boschi cedui	3
4030	Lande secche europee	31.2	Brughiere aride	F4.2	Brughiere aride	4
4030	Lande secche europee	31.21	Brughiere submontane a mirtilli	F4.21	Brughiere montane con *Calluna* sp. e *Vaccinium* sp.	4
4030	Lande secche europee	31.214	Lande submontane alpine a *Vaccinium*	F4.214	Brughiere submontane alpine a *Vaccinium*	4
4030	Lande secche europee	31.22	Brughiere subatlantiche a *Calluna* e *Genista*	F4.22	Brughiere sub-atlantiche con	4

					Calluna sp. e *Genista* sp.	
4060	Lande alpine e boreali		31.4	Brughiere alpine e boreali	F2.2	Brughiere ed arbusteti sempreverdi, alpini e sub-alpini	4
4070	Boscaglie di *Pinus mugo* e *Rhododendron hirsutum* (Mugo-Rhododendretum hirsuti)	Prioritario	31.5	Formazioni a *Pinus Mugo*	F2.4	Cespuglieti di conifere prossimi al limite degli alberi	4
			31.6	Cespuglieti e formazioni a megaforbie subalpine	F2.3	Comunità arbustive sub-alpine e oroboreali di caducifoglie	3
			31.61	Cespuglieti a Ontano verde	F2.31	Cespuglieti montani ad Alnus	3
			31.611	Cespuglieti alpini a Ontano verde	F2.311	Cespuglieti ad Alnus viridis	3
			31.611	Cespuglieti alpini a Ontano verde	F2.3111	Cespuglieti alpini di *Alnus viridis*	3
			31.62	Saliceti arbustivi	F2.32	Comunità arbustive sub-alpine e oroboreali di *Salix* sp.	3
			31.621	Saliceti arbustivi pirenaico-alpini	F2.321	Arbusteti a salici pirenaico-alpini	3

4080	Boscaglie subartiche di *Salix* spp.	31.6211	Cespuglieti di salici alpini di piccola taglia	F2.3211	Cespuglieti bassi di salici alpini	4
		31.6212	Cespuglieti di salici prostrati	F2.3212	Arbusteti di salici alpini prostrati	3
		31.6213	Cespuglieti di salici di alta taglia	F2.3213	Boscaglie alpine ad alti Salici	3
		31.63	Megaforbieti alpini misti a arbusti	F2.335	Cespuglieti subalpini ad ericacee	3
		31.7	Arbusti spinosi emisferici delle alte montagne mediterranee (Astragalus sp. pl.)	F7.4	Lande montane di cespugli a pulvino	3
4090	Lande oro-mediterranee endemiche a ginestre spinose	31.75	Arbusti spinosi emisferici corsico-sardi	F7.45	Arbusti spinosi emisferici corsico-sardi	4
		82.12	Serre e orti	I1.2	Orti, serre ed altre colture miste	1
		82.2	Sistemi agricoli intensivi con resti di vegetazione spontanea	X07	Campi coltivati intensamente con striscie di vegetazione naturale e semi-naturale	1
		82.3	Colture di tipo estensivo	I1.3	Monocolture estensive, coltivate lavorate	2

				tecniche tradizionali e a bassa produttività	
	82.4	Seminativi allagati	I1.4	Coltivazioni irrigate, risaie ed altri terreni agricoli temporaneamente inondati	2
	86.1	Città, Centri abitati	J1	Aree urbane densamente edificate	0
	86.1	Città, Centri abitati	J1.1	Centri storici e residenziali in città di dimensioni medio-grandi	0

Annex 2

Delivery risk guidelines for restoring or creating habitats

This guideline is based on DEFRA's offsetting metric, Appendix 2: Risk factors for restoring or recreating different habitats (DEFRA, 2011b).

Table A gives the value of the delivery risk factor to use as multiplier for the habitats restored or created in offsetting projects. Table B provides a list of different types of habitats and indicates its level of difficulty to restored or recreated.

Note that this values follow the DEFRAs guidelines and still a specific Italian consultation needs to be completed to adapt and adequate this habitats and values for the Italian biotopes. These values are purely a guideline and depending on the specific cases this values may change according to substrate, nutrient levels, state of existing habitat etc. Final risks values should be agreed case by case as part of setting up the offset.

Table A. Risk multipliers

Difficulty of restoration/creation	Multiplier
Very High	10
High	3
Medium	1.5
Low	1

Table B. Technical difficulty guidelines for some habitat creation and restoration

Habitat type	Technical difficulty for creation	Technical difficulty for restoration
Aquifer fed naturally Fluctuating water bodies	Very high impossible	Medium
Arable field margins	Low	N/A
Blanket bog	Very high/impossible	High
Calaminarian grasslands	High	Medium
Coastal and floodplain grazing marsh	Low	Low
Coastal saltmarsh	Medium	Medium
Coastal sand dunes	Very high/impossible	Medium
Coastal Vegetated shingle	High	High

Eutrophic Standing waters	Medium	Medium
Hedgerows	Low	Low
Inland rock outcrop and scree habitats	Very high/impossible	Medium
Limestone paviments	Very high/impossible	Medium
Lowland beech and yew woodland	Medium	Low
Lowland calcareous grassland	Medium	Low
Lowland dry acid grassland	Medium	Low
Lowland fens	Medium	Low
Lowland heathland	Medium	Medium
Lowland meadows	Medium	Low
Lowland mixed deciduous woodland	Medium	Low
Lowland raised bog	Very high/impossible	Medium
Maritime cliff and slopes	Very high/impossible	High
Mountain heaths and willow Scrub	High	Medium
Oligotrophic and Dystrophic Lakes	Medium	Medium
Open Mosaic Habitats on Previously Developed Land	Low	Low
Ponds and freshwater channels	Low	Low
Purple Moor Grass and Rush Pastures	High	Medium
Reedbeds	Low	Low
Saline lagoons	Low	Low
Traditional orchards	Low	Low
Upland calcareous grassland	High	Medium
Upland Flushes, Fens and swamps	High	Medium
Upland hay meadows	Medium	Low
Upland heathland	Medium	Medium
Upland mixed ashwoods	Medium	Low
Upland oakwood	Medium	Low
Wet woodland	Medium	Low

Wet heath	High	High
Wood-pasture & parkland	Medium	Low

Annex 3

Temporal risk multiplier guidelines for restoring or creating habitats

This guideline is based on DEFRA's offsetting metric, Appendix 2: Feasibility and timescales of restoring-Examples from Europe (DEFRA, 2012) and TEEB 2010 Table 9.1, Chapter 9, page 7 of The Economics of Ecosystems and Biodiversity for national and International Policy Makers (Besshöver et al., 2009).

Table A gives the value of the time risk factor to use as multiplier for the habitats restored or created in offsetting projects. Table B provides a list of different types of European habitats and indicates their estimated time for creation/restoration.

Note that this values follow the DEFRAs (2012) and TEEB (2010) guidelines and still a specific Italian consultation needs to be completed to adapt and adequate this habitats and values for the Italian biotopes. These values are purely a guideline and depending on the specific cases this values may change according to substrate, nutrient levels, state of existing habitat etc. Final risks values should be agreed case by case as part of setting up the offset.

Table A. Temporal risk multipliers

Years to target condition	Multiplier
5	1.2
10	1.4
15	1.7
20	2
25	2.4
30	2.8
32	3

Table B. Temporal risk multiplier guideline for some European habitats

Ecosystem type	Time-scale	Notes
Temporary pools	1-5 years	Even when rehabilitated, may never support all pre-existing organisms.
Eutrophic ponds	1-5 years	Rehabilitation possible provided adequate water supply. Readily colonized by water beetles and dragonflies but fauna restricted to those with limited specializations.
Mudflats	1-10 years	Restoration dependent upon position in tidal frame and sediment supply. Ecosystem services: flood regulation, sedimentation.
Eutrophic grasslands	1-20 years	Dependent upon availability of propagules. Ecosystem services: carbon sequestration, erosion regulation and grazing for domestic livestock and other animals.
Reedbeds	10-100 years	Will readily develop under appropriate hydrological conditions. Ecosystem services: stabilization of sedimentation, hydrological processes.
Saltmarshes	10-100 years	Dependent upon availability of propagules, position in tidal frame and sediment supply. Ecosystem services: coastal protection, flood control.
Oligotrophic grasslands	20-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Chalk grasslands	50-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Yellow dunes	50-100 years +	Dependent upon sediment supply and availability of propagules. More likely to be restored than re-created. Main ecosystem service: coastal protection.
Heathlands	50-100 years +	Dependent upon nutrient loading, soil structure and availability of propagules. No certainty that vertebrate and invertebrate assemblages will arrive without assistance. More likely to be restored than re-created. Main ecosystem services: carbon sequestration, recreation.
Grey dunes and dune slacks	100-500 years	Potentially restorable, but in long time frames and depending on intensity of disturbance Main ecosystem service: coastal protection, water purification.
Ancient woodlands	500 – 2000 years	No certainty of success if ecosystem function is sought – dependent upon soil chemistry and mycology plus availability of propagules. Restoration is possibility for plant assemblages and ecosystem services (water regulation, carbon sequestration, erosion control) but questionable for rarer invertebrates.
Blanket/Raised bogs	1,000 – 5,000 years	Probably impossible to restore quickly but will gradually reform themselves over millennia if given the chance. Main ecosystem service: carbon sequestration.
Limestone pavements	10,000 years	Impossible to restore quickly but will reform over many millennia if a glaciation occurs.

Annex 4

Offset habitat credits calculation model

The following tables show how the deliverable habitat credits are calculated using the offset receptor site 44.61 hop-hornbeam riparian forest.

This calculation steps are the same for all types of offsets.

OFFSET HABITAT CREDITS CALCULATION

Input information

Offset receptor habitat type	*44.61 hop-hornbeam riparian forest*	
Type of offset	*Improvement action/management to control invasive species*	
Offset multipliers	*Spatial*	1
	Delivery (medium difficulty)	1.5
	Temporal (10 years)	1.4
Net habitat debits to be offset	*178.78*	

	Habitat's current natural status	Habitat's target natural status
Condition	1	3
Distinctiveness	4	4
Area	8	8

OFFSET HABITAT CREDITS CALCULATION MODEL

Habitat credits of receptor site current condition

Distinctiveness	Condition	Offset factor	Area, ha	Current habitat credits
4	1	4	8	=4*8

Habitat credits of receptor site target condition

Distinctiveness	Condition	Offset factor	Area, ha	Target habitat credits
4	3	12	8	=12*8

Deliverable habitat credits

Current	Target	Spatial risk	temporal risk	Delivery risk	Deliverable tot habitat credits
=4*8	=12*8	1	1.4	1.5	= ((4*8)-(12*8))/(1*1.4*1.5)

Habitat credits/ha

=(((4*8)-(12*8))/(1*1.4*1.5))/8

Total hectares of receptor site needed to offset the net habitat debits

=178.78 / ((((4*8)-(12*8))/(1*1.4*1.5))/8)

OFFSET HABITAT CREDITS CALCULATION RESULTS

Habitat credits of receptor site current condition

Distinctiveness	Condition	Offset factor	Area, ha	Current habitat credits
4	1	4	8	=32

Habitat credits of receptor site target condition

Distinctiveness	Condition	Offset factor	Area, ha	Target habitat credits
4	3	12	8	=96

Deliverable habitat credits

Current	Target	Spatial risk	Temporal risk	Delivery risk	Deliverable tot habitat credits
=32	=96	1	1.4	1.5	=30.48

Habitat credits/ha

= 3.81

Total hectares of receptor site needed to offset the net habitat debits

= 46.93

Annex 5

Conservation Banking Consultation of regulators and practitioners

This annex presents the questions included in the survey sent to regulators and practitioners related with the Conservation Banking Program of the USA. Such questions were adapted from the previous study elaborated by Bunn et al. in 2013.

Practitioners were questioned all questions included in the following questionnaire as those are related with the profitable activity of a conservation bank. Whilst regulators were asked only from question 6 to 11 only.

Biodiversity Banking in USA
Consultation
2015

General comments

A scientific research is being carried out at the University of Padua in collaboration with the University of California Davis for studying the American and Italian mechanism of environmental compensation related to development projects. The objective is to assess the positive factors and pitfalls of the conservation banking in the USA. A parallel study is conducted in Italy to identify the different compensation mechanisms and evaluate their performance.

The results of this study will provide reliable information to update the status of the conservation banking in the USA, as well as to evaluate and analyze the incentives-disincentives of the program by considering the conservation agencies and banking practitioner's opinion.

Instructions

We kindly ask you to participate in this consultation process and respond to the following 6 questions. We appreciate very much your time and willingness to participate. We want you to know that your opinion is very valuable and in return for sharing your views, we will be glad to inform you the results of this study.

Should you have any problem with this online survey please send an email to ariadna.chavarriaresendez@studenti.unipd.it. In case you prefer to answer offline, you are welcome to fill the .doc document that has been attached to the email and send it to the same email address. The PhD candidate Ariadna Chavarria is the responsible for this survey, and will be happy to resolve any issue you may encounter.

This consultation is part of a PhD dissertation supported by the Italian Ministry of Education, Universities and Research. Your answers will be kept anonymous. All the information will be exclusively used for research purposes and will not be shared with third parties.

The estimated time to complete this survey is 15 min.

Thank you in advance for your participation and support.

Università degli Studi di Padova

Supporting Accademic Institutions

UC Davis University of California

For any questions, please don't hesitate to contact:
Ariadna Chavarria Resendez (PhD candidate)
University of Padua, TeSAF Department
Via dell'Università 16- 35020 Legnaro (PD)
✉ ariadna.chavarriaresendez@studenti.unipd.it
✆ +1 530 9794380

QUESTIONNAIRE

Name of the person completing the questionnaire: Click here to enter text.
Name of your organization: Click here to enter text.
Position: Click here to enter text.
Would you like to receive information about the results of this study? Yes☐ No☐

Please provide your opinion to the following respond to the following questions by checking the boxes:

1. What was the motivation for the conservation bank establishment?

Conservation	☐
Financial for profit	☐
Financial for non-profit	☐
Other: Click here to enter text.	☐

If you answered to 1 was financial for profit or non-profit, please answer this question:

1.1 What is the economic success that betters describes the bank situation?

Breaking even or operating with gain	☐
Operating with loss	☐
I prefer not to answer	☐

2. Select the option(s) that better describe the situation under which the bank was created:

Under the situation of	
Acquisition of existing habitat	☐
Creation of a bank in an already owned land	☐
Protection of existing habitat through conservation easements	☐
Restoration or enhancements of disturbed habitat	☐
Creation of new habitat	☐
Other: Click here to enter text.	

3. What are the activities allowed in the bank:

Activity	
Cattle grazing	☐
Hunting	☐
Horseback riding	☐
Hiking	☐

Fishing	☐
Biking	☐
Camping	☐
Other: Click here to enter text.	

4. What is the ownership of the conservation bank:

Public organization	☐
Private Organization	☐
Other: Click here to enter text.	

5. Intended use of the credits:

Internal use-Single user	☐
Sold to third parties	☒
Other: Click here to enter text.	

Please provide your opinion to the following 6 questions about banking program for conservation or mitigation according with your experience.

6. What are the most important criteria for selecting and approving conservation banks? Rank the given factors from 1 to 13. Number 1 will be the most important factor and 13 the less important.

Criteria	Ranking of importance from 1 to 13
Habitat and species value	Click here to enter text.
Site connectivity	Click here to enter text.
Financial soundness	Click here to enter text.
Site sustainability	Click here to enter text.
Markets for credits	Click here to enter text.
Site size	Click here to enter text.
Regional conservation value	Click here to enter text.
Manageable stewardship	Click here to enter text.
Wildlife agencies' support	Click here to enter text.
No easement restrictions	Click here to enter text.
Local government support	Click here to enter text.
Landowners willingness	Click here to enter text.
Restoration potential	Click here to enter text.

7. What are the greatest challenges of site selection and approval? Rank the given challenges from 1 to 15. Number 1 will be the most important factor

Challenging factor	Ranking of importance from 1 to 15
Lack of agency program staff	Click here to enter text.
Process too long, administrative burden and uncertainty	Click here to enter text.
Ensuring conservation success	Click here to enter text.
Cost assessing financial risks	Click here to enter text.
Determining service area	Click here to enter text.

Getting agencies to agree	**Click here to enter text.**
Determining credit value and release schedule	**Click here to enter text.**
Finding sites to meet habitat and species criteria	**Click here to enter text.**
Assessing market for credits	**Click here to enter text.**
Assessing risks that threaten the physical site including title	**Click here to enter text.**
Working with landowners not affiliated with CB firm	**Click here to enter text.**
Lack of guidance of what agencies want	**Click here to enter text.**
Negative perception of program (internally and externally)	**Click here to enter text.**
Gaining legal access to site for review	**Click here to enter text.**
Communications between banks and agencies	**Click here to enter text.**

8. What are the most difficult issues to resolve for approval of a conservation bank?
Rank the given issues from 1 to 18. Number 1 will be the most important factor

Challenging factor	Ranking of importance from 1 to 18
Biodiversity values linked to the site credit	**Click here to enter text.**
Service area	**Click here to enter text.**
Funding site management	**Click here to enter text.**
Title and easement issues	**Click here to enter text.**
State and federal agency agreement	**Click here to enter text.**
Endowment issues	**Click here to enter text.**
Estimating cost	**Click here to enter text.**
Process length	**Click here to enter text.**
Access to site	**Click here to enter text.**
Changing templates	**Click here to enter text.**
Pollution on site	**Click here to enter text.**
Fully assessing bio status of site	**Click here to enter text.**
Ensuring market is adequate	**Click here to enter text.**
Ability to maintain site long term	**Click here to enter text.**
Getting agencies support early	**Click here to enter text.**
Site management flexibility	**Click here to enter text.**
Reducing program bureaucracy	**Click here to enter text.**
Political interventions	**Click here to enter text.**

9. Most important barriers to new conservation banks.
Rank the given issues from 1 to 11. Number 1 will be the most important factor

Challenging factor	Ranking of importance from 1 to 11
Approval process too long In your experience, how long does the process take? Click here to enter text.	**Click here to enter text.**
Upfront and management costs	**Click here to enter text.**
Lack of market	**Click here to enter text.**
Lack of dedicated agency staff	**Click here to enter text.**
Endowment disagreements	**Click here to enter text.**
Process uncertainty	**Click here to enter text.**
Land owner perceptions	**Click here to enter text.**
Lack of regional plan	**Click here to enter text.**
Conflicts with NCCPs/HCPs	**Click here to enter text.**
Difficult process	**Click here to enter text.**

Disagreement on management	**Click here to enter text.**

10. What are the most important factors to evaluate the bank's service area and to assess the number of credits deliverable? Please consider the factors you may add into the ranking. The number 1 represents the most important factor.

Factors	Ranking of importance
Service area	Click here to enter text.
Presence of endangered/ threatened species	**Click here to enter text.**
Habitat diversity occurrence	**Click here to enter text.**
Site connectivity	**Click here to enter text.**
Range of ecosystem services delivered	**Click here to enter text.**
Site condition	**Click here to enter text.**
Site restoration or creation	**Click here to enter text.**
Other factors you consider important:	
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**

11. What are the most important factors to value the bank's credits in monetary terms? Please consider the factors you may add into the ranking. The number 1 represents the most important factor.

Factors	Ranking of importance
Land price	**Click here to enter text.**
Management cost	**Click here to enter text.**
Rarity of the type of credits	**Click here to enter text.**
Transaction costs	**Click here to enter text.**
Profit forgone	**Click here to enter text.**
Up-front investment	**Click here to enter text.**
Other factors you consider important:	
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**
Click here to enter text.	**Click here to enter text.**

Thank you for your valuable cooperation!

If you have further remarks or ideas about this study, in general about biodiversity offsetting and/or about the questionnaire, please use the following space to share your thoughts.

Click here to enter text.

Annex 6

Survey results of the Conservation Banking Consultations for practitioners and regulators

Thank you for participating

Biodiversity Banking in USA
Consultation Finding
2015 Consultation

A scientific research was carried out at the University of Padua in collaboration with the University of California Davis (April - June 2015) for studying the American mechanism of environmental compensation related to development projects. The objective was to assess the positive factors and pitfalls of the Conservation Banking in the USA from the agency staff members and practitioners point of view. This study was based on the study realized in 2013 for the California Conservation Banking Program (Bunn, 2013), but the fundamental premise is that a nationwide study will give a more reliable data of the limiting factors and positive features of Conservation Banking Program that may be of help for further policy changes in the U.S. Fish and Wildlife Service Mitigation Policy.

The findings of this study are presented in this report. First a brief background on conservation banking is presented, later this study's design is explained and the respondent's data. Next, the findings summary and conclusion are presented, and finally, the detailed responses data is shown.

Note
The banks in California that were only approved by the State were not considered to respond this questionnaire with the aim of collecting data from practitioners interacting with the Federal Environmental Agencies involved in their Conservation Banking activities.

Università degli Studi di Padova

Supporting Accademic Institutions

UC DAVIS
UNIVERSITY OF CALIFORNIA

For any questions, please don't hesitate to contact:
Ariadna Chavarria Resendez (PhD candidate)
University of Padua, TeSAF Department
Via dell'Università 16- 35020 Legnaro (PD)
ariadna.chavarria@gmail.com

Background

Conservation Banking provides a mechanism for developers to mitigate their impacts on wildlife, i.e. endangered species and species of concern. Likewise, it offers ranchers and landowners a source of income for managing their land to benefit wildlife.

Conservation Banking was developed after the mitigation banking program by the State of California in 1995. The California Fish and Game published the official policy on conservation banking (Wheeler and Strock, 1995) reinforcing the development of option for wildlife mitigation. In 2003 the U.S. Fish and Wildlife Service released a guidance document for establishment and operation of conservation banks across the nation.

The purposes of the program are: 1) conserve important habitats and habitat linkages, 2) provide alternatives to the project-by-project mitigation approach, 3) take advantage of economies of scale not available to individual mitigation projects, 4) provide incentives for private landowners to protect species, 5) provide additional funding to execute regional conservation plans (Wheeler and Strock, 1995).

Study design

The online questionnaire was sent to 34 bank sponsors of approved Conservation Banks in the USA and to 20 agency staff members related with the banks surveyed.

Source of banks and bank sponsors data:
-Ecosystem Market Place Data Base for Conservation Banking of Endangered Species
us.speciesbanking.com
- The National Registry for Conservation and Mitigation Banks of the Federal US Government: Regulatory In-Lieu Fee and Bank Information Tracking System
Ribits.usace.army.mil/ribits_apex

Survey question were designed to:

1- Assess the criteria used to select new conservation banks and identify what changes may be needed to ensure the best sites are selected.
2- Asses the challenges and barriers to implement an effective program nationwide.
3- Identify policy changes that may help improving the program.

Respondents data

Total bank sponsors/ Total of respondents: 11
Total banks represented: 20
Response rate: 34%
Distribution of respondent:
- TX & UT – 1 (each)
- FL - 2
- CA - 7

Distribution of banks represented:
- TX – 3
- UT – 1
- FL – 4
- CA – 12

States with Conservation Banks that did not answer this questionnaire:

Arizona - 2 Bank	Oklahoma - 2 Banks	South Carolina – 1 Bank
Mississippi - 1 Bank	Oregon – 2 Bank	Washington – 2 Bank
Colorado – 1 Bank		

Total of wildlife agency staff members: 8
Response rate: 40%
Responding agencies: California Fish and Wildlife, US Army Corps of Engineers, Colorado Department of Transportation, Natural Resources Conservation Services, and Santa Cruz Planning Department.

The agency staff member where sent an online questionnaire with the questions 6 to 11 only.

Findings summary and conclusion

Bank practitioner's facts (question 1 to 5)

The most frequent motivations for establishing a conservation bank are conservation and financial for-profit activity. 64% of the respondents agreed that those are the most motivating activities for establishing a new bank. In fact, 100% of the responses stated their banks sell the credits to third parties, and 91% responded to represent a private owned bank. 70% of the banks surveyed were created for restoration and enhancement of disturbed habitat, and 75% of the banks represented in this study operate with profit.

The most popular activities allowed in conservation banks are:
Cattle grazing, 21%
Hiking, 28%, and
Horseback riding, 10%

Bank practitioners and agency staff members point opinion on:

- **Criteria for approving a conservation bank (question 6)**

Survey respondents have different priorities of criteria to select/approve a conservation bank. Agency staff members identified the top three are: habitat and species value, restoration potential and site sustainability. On the other hand, practitioners agreed that the three most important criteria are: habitat and species value, the financial soundness of the bank and the market for its credits. The number 5 and 6 most important criteria for agency members includes markets for credits and financial soundness as for the bankers these criteria are in the top three.

As expected agency members prioritize the biological features of conservation banks, while bank practitioners emphasized the importance of the credits market and financial risks more than agencies.

- **Criteria for selecting the site for a conservation bank (question 7)**

Agency staff selected the following criteria in the top three most important for site selection: 1) Finding sites to meet habitat and species criteria, 2) lack of agency staff in the program and 3) assessing the markets for credits. For practitioners, the three most important criteria are: 1) the lack of agency staff, 2) the processing time, admin burden and uncertainty, and 3) getting the agencies to agree with the bank's site proposed.

Bank practitioners are more concern about the interaction with the agencies approving their proposed site for conservation banks, and the time needed to get approved. Both, agencies and practitioners, agreed that one of the top three criteria for selecting a site is the lack of agency staff dedicated to conservation banking.

- **Most difficult issues to resolve for approving a conservation bank (question 8)**

Of the 18 issues to resolve for approving a conservation bank the top three of bank practitioners are again very related with the bureaucracy and approval from the agencies: 1) State and federal agency agreement (mostly in California), 2) Process length, 3) reducing program bureaucracy. Whilst, agency staff top three most difficult criteria to resolve for approving a conservation bank is related with: 1) Biodiversity values linked to the site credits, 2) funding the site management, and 3) estimating the costs.

These three concerns of agencies are very often covered in the New Bank proposal and the fact that were indicated as the top three most important criteria shows the agency's concern that the bank will have enough funding to sustain the species.

- **Barriers to new conservation banks (question 9)**

Considering all the program challenges practitioners and agencies mostly agreed in the top three barriers for new conservation banks. Both, agencies and practitioners agreed that the most important barrier is the approval process being too long. In fact, the majority of the practitioners stated the process last from 2 to 3 years. But in occasions it can go up to 7 years (1 respondent). Agency staff second most important barrier is the upfront and management cost, while practitioners are most worried by the lack of market. The lack of market has been selected as the third most important barrier by agencies, while for practitioners is the lack of dedicated agency staff.

- **Most important factors to value the bank's service area and available credits (question 10)**

Both, agencies and practitioners shown agreement on the three most important factors to assess the bank's service area and available credits:

1) Species distribution
2) Presence of endangered/threatened species
3) Habitat diversity

Another factor suggested by both group of respondents was the site's ecological uplift potential.

- **Most important factors to value the bank's credits in monetary terms (question 11)**

For agencies the most important factors to value the credits in monetary terms generally agree with practitioners. However, practitioners find in the rarity of the credits type an important factor to consider when pricing the credits.

Agency top three: 1) Up-front investment, 2) land-price, 3) management cost.
Practitioners top three: 1) land price, 2) management cost, 3) rarity of credits type.

Conclusions and recommendations

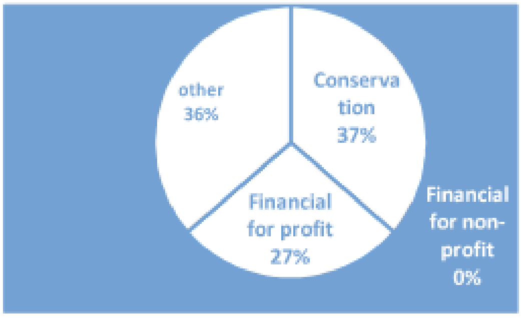
Considering the most important issues and problems to resolve in Conservation Banking selected by agency staff members and practitioner surveyed there is a clear difference in the priorities that agencies and practitioners consider when thinking about selecting and approving a conservation bank. Agencies, as it can be expected, are more incline for the biology and ecological sustainability of the site than the credits market and time need.

The results of this study show that 75% of the banks operate for profit and are of private ownership. Thus, practitioners concern related with Conservation Banking profitability is considerably important. Both, agencies and practitioners agree that the lack of agency staff is one of the most important factors that relates with long time to process a new bank proposal and the program bureaucracy. The designation of more agency staff to Conservation Banking, and offering them training on the business of banking would improve the implementation of the conservation Banking Program. It may help agency staff to the understanding between practitioners and agencies. It would contribute to tackle the barriers for the creation of new conservation banks as the long time for approval needed, and uncertainty of agencies that the banks will offer suitable funding for the site management in perpetuity.

Detailed responses data

1. What was the motivation/s for establishing the conservation bank?

Conservation	4
Financial for profit	3
Financial for non-profit	0
Other	4



Other motivations given by bank practitioners:

-Conservation for conservationist, profit for landowner

- Best use of land given location

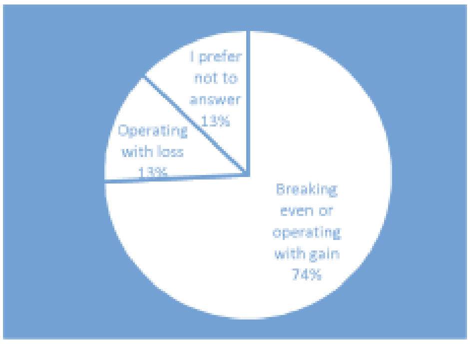
-Three-pronged: 1) Conservation/Recovery of the Species; 2) Provide Financial Incentive for Conservation; 3) Provide an Avenue for Development in Restricted Areas.

- Banks contributes to conservation of threatened species

-A combination of conservation and non profit

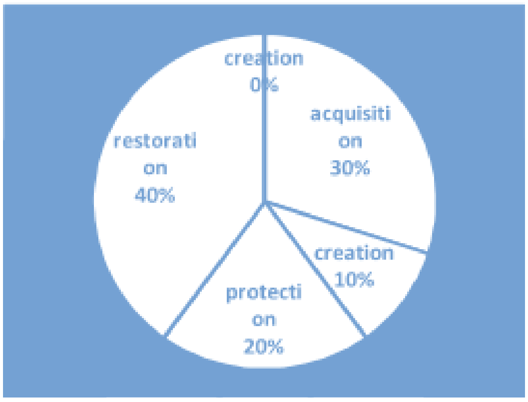
1.a. If your answer to 1 was financial for profit or non-profit, please answer this question: What is the economic success that betters describes the bank situation?

Answer	Responses	%
Breaking even or operating with gain	6	75%
Operating with loss	1	13%
I prefer not to answer	1	13%



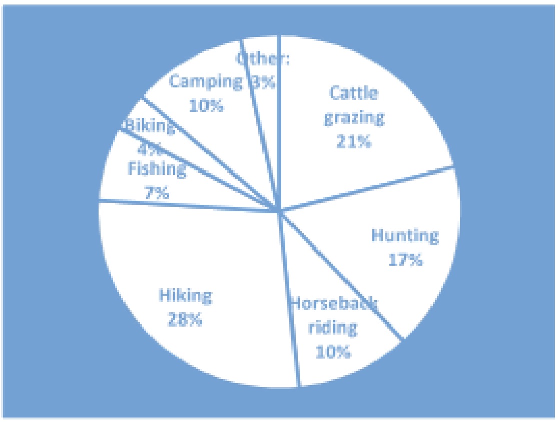
2. Select the option(s) that better describe the situation under which the bank was created:

Under the situation of:	
Acquisition of existing habitat	3
Creation of a bank in an already owned land	1
Protection of existing habitat through conservation easements	2
Restoration or enhancements of disturbed habitat	4
Creation of new habitat	0
Other: We created a bank on already owned land and two banks on the acquisition of existing habitat	1



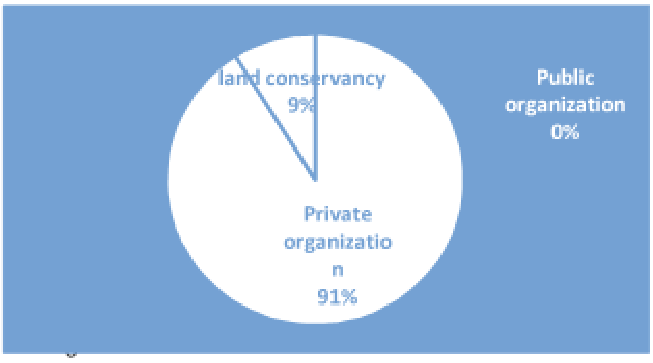
3. What are the activities allowed in the bank?

Activity	
Cattle grazing	6
Hunting	5
Horseback riding	3
Hiking	8
Fishing	2
Biking	1
Camping	3
Other: 1. Compatible farming, i.e. raising hay	1



4. What is the ownership of the conservation bank?

Public organization	0
Private Organization/ landowner	9
Other: 1. Land conservancy	1



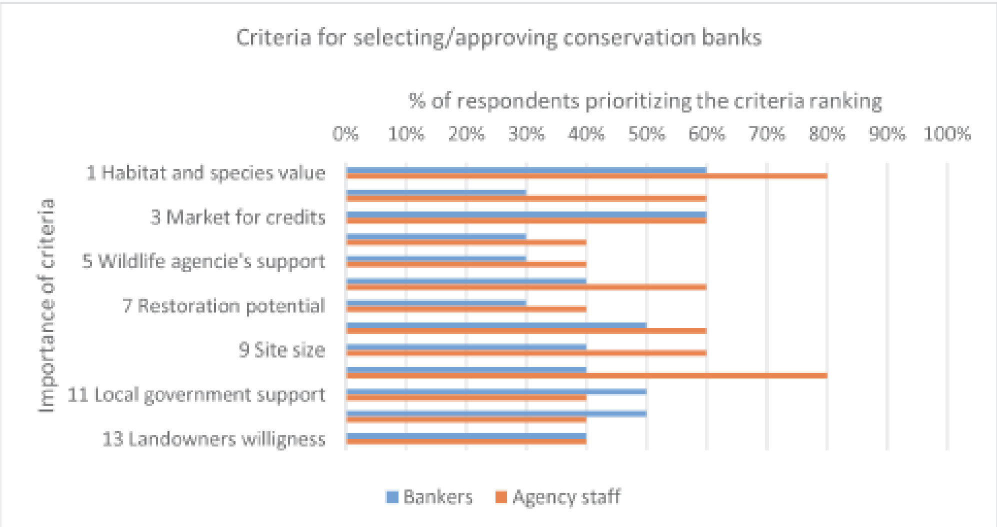
5. Intended use of the credits:

Internal use-single user	0
Sold to third parties	11
Other	0

The following answers were ranked according to the highest number of respondents selecting the same number to prioritize each the options given for the question.

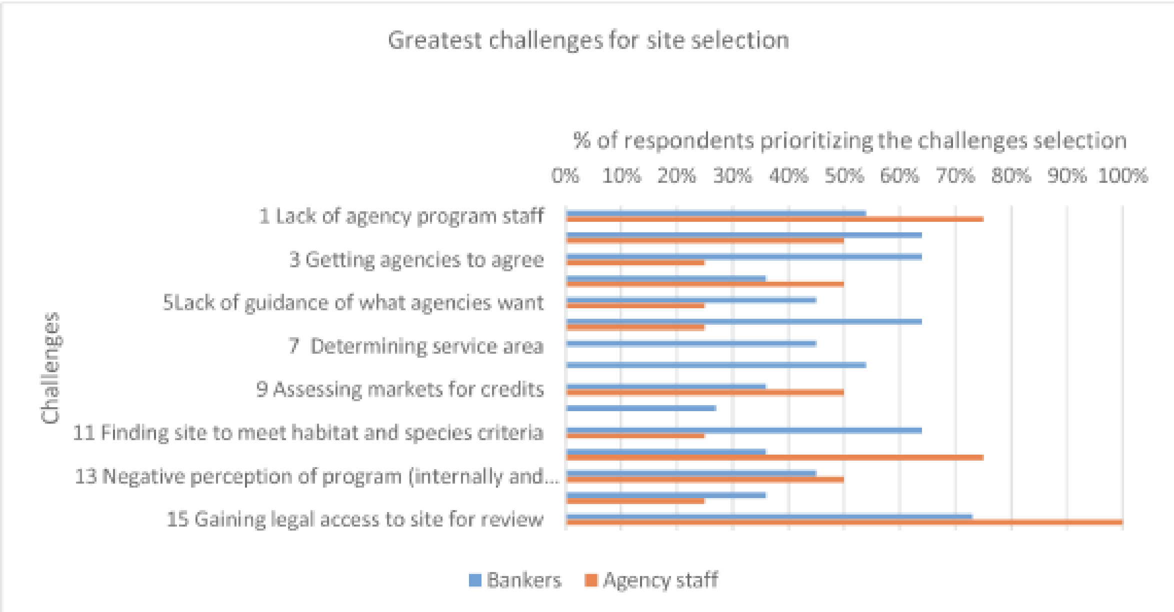
6. What are the most important criteria for selecting and approving conservation banks?
Rank the given factors from 1 to 13. Number 1 will be the most important factor and 13 the less important.

Criteria	Ranking of importance From 1 to 13		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Habitat and species value	1	1	60%	80%
Site connectivity	10	4	40%	80%
Financial soundness	2	6	30%	60%
Site sustainability	8	3	50%	60%
Markets for credits	3	5	60%	60%
Site size	9	10	40%	60%
Regional conservation value	4	11	30%	40%
Manageable stewardship	6	7	40%	60%
Wildlife agencies' support	5	9	30%	40%
No easement restrictions	12	13	60%	60%
Local government support	11	12	50%	40%
Landowners willingness	13	8	40%	40%
Restoration potential	7	2	30%	40%



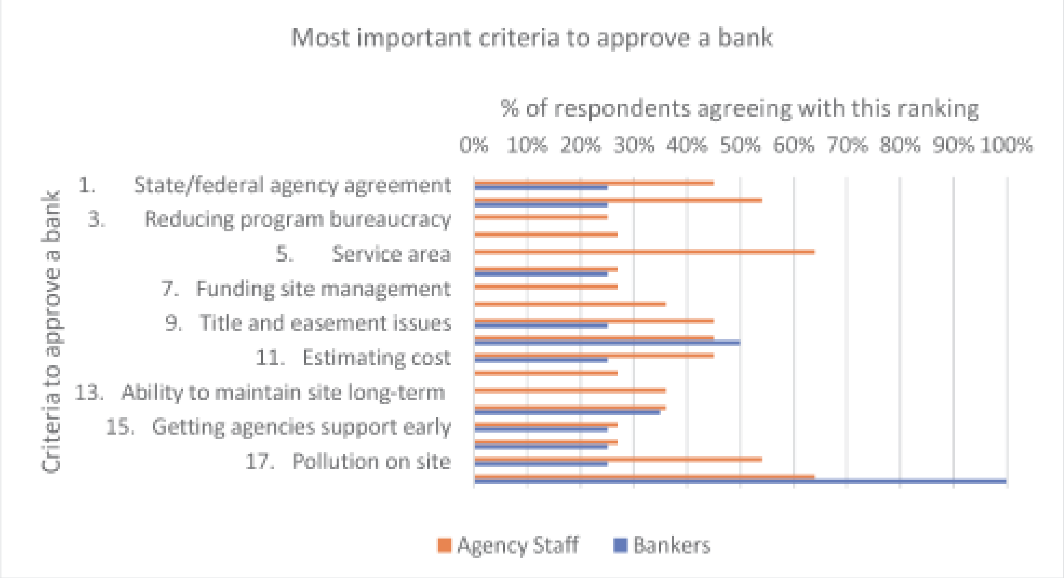
7. What are the greatest challenges of site selection and approval?
Rank the given challenges from 1 to 15. Number 1 will be the most important factor.

Challenging factor	Ranking of importance From 1 to 15		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Lack of agency program staff	1	2	54%	75%
Process too long, administrative burden and uncertainty	2	5	64%	50%
Ensuring conservation success	4	4	36%	50%
Cost assessing financial risks	8	6	54%	0%
Determining service area	9	9	36%	50%
Getting agencies to agree	3	7	64%	25%
Determining credit value and release schedule	6	8	45%	25%
Finding sites to meet habitat and species criteria	10	1	27%	0%
Assessing market for credits	11	3	64%	25%
Assessing risks that threaten the physical site including title	7	10	45%	0%
Working with landowners not affiliated with CB firm	12	11	36%	75%
Lack of guidance of what agencies want	5	13	45%	25%
Negative perception of program (internally and externally)	13	15	45%	50%
Gaining legal access to site for review	15	14	73%	100%
Communications between banks and agencies	14	12	36%	25%



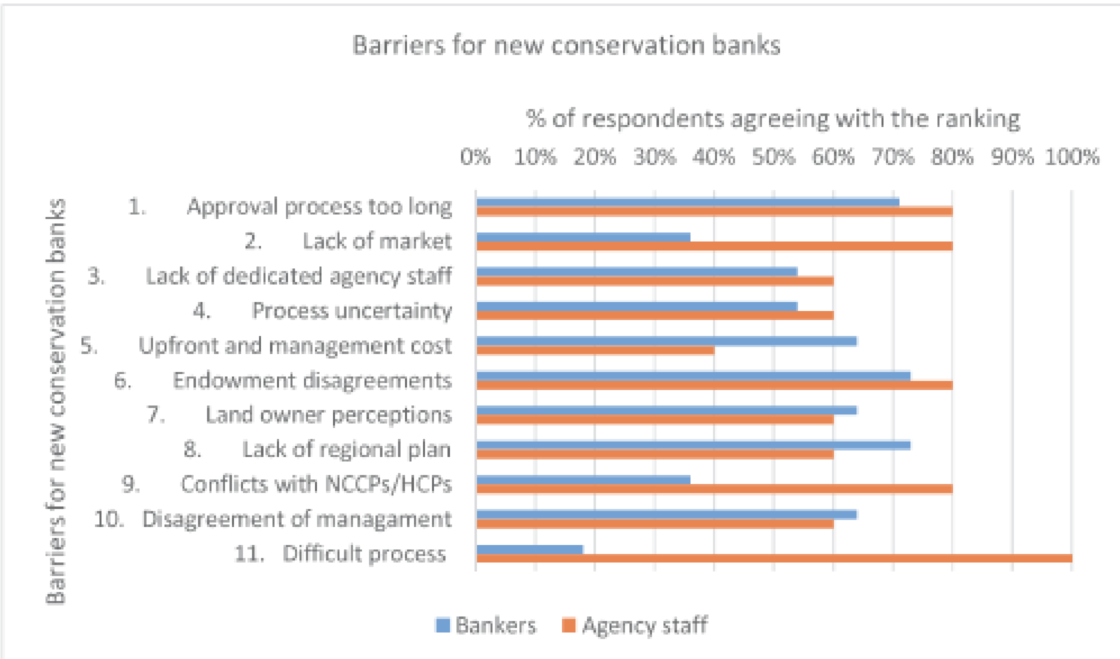
8. What are the most difficult issues to resolve for approval of a conservation bank?
Rank the given issues from 1 to 18. Number 1 will be the most important factor

Challenging factor	Ranking of importance From 1 to 18		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Biodiversity values linked to the site credits	6	1	27%	25%
Service area	5	12	64%	0%
Funding site management	7	2	27%	0%
Title and easement issues	9	6	45%	25%
State and federal agency agreement	1	7	45%	25%
Endowment issues	10	8	45%	50%
Estimating cost	11	3	45%	25%
Process length	2	6	54%	25%
Access to site	12	15	27%	0%
Changing templates	4	16	27%	0%
Pollution on site	17	14	54%	25%
Fully assessing bio-status of site	14	11	36%	25%
Ensuring market is adequate	8	4	36%	0%
Ability to maintain site long term	13	5	36%	0%
Getting agencies support early	15	13	27%	25%
Site management flexibility	16	9	27%	25%
Reducing program bureaucracy	3	10	45%	0%
Political interventions	18	18	64%	100%



9. Most important barriers to new conservation banks.
Rank the given issues from 1 to 11. Number 1 will be the most important factor

Challenging factor	Ranking of importance from 1 to 11		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Approval process too long In your experience, how long does the process take?* *See 9.a	1	1	71%	80%
Upfront and management costs	5	2	64%	40%
Lack of market	2	3	36%	80%
Lack of dedicated agency staff	3	4	54%	60%
Endowment disagreements	6	7	73%	80%
Process uncertainty	4	5	54%	80%
Land owner perceptions	7	8	64%	60%
Lack of regional plan	8	9	73%	60%
Conflicts with NCCPs/HCPs	9	10	36%	80%
Difficult process	11	11	18%	100%
Disagreement on management	10	6	64%	60%



9.A. In your experience, how long does the process take? Bankers responses:

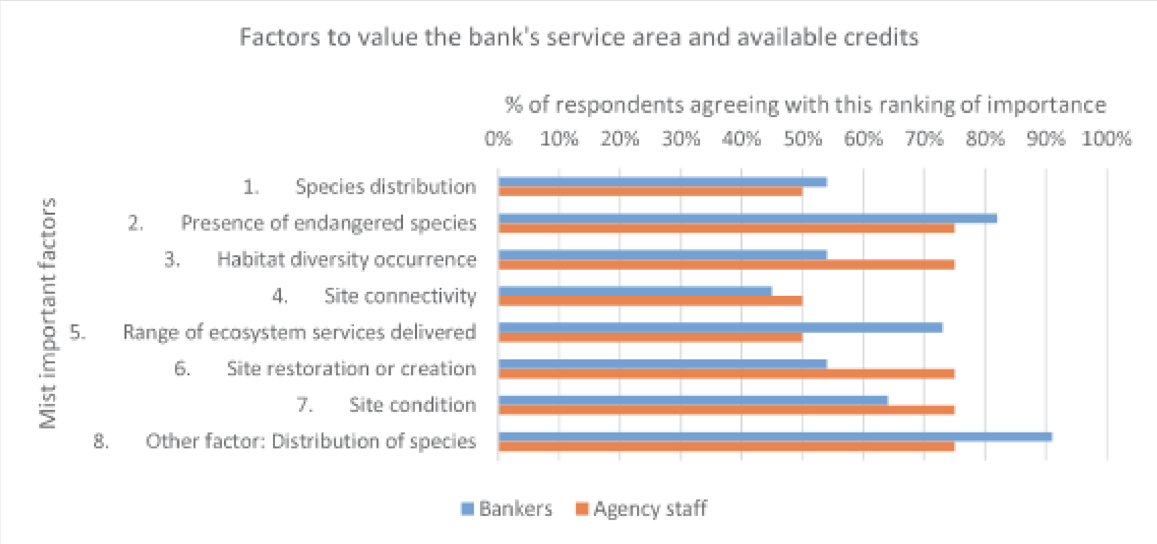
Time, years	Number of practitioners
1-2	2
2-3	5
3-5	3
5-7	1

10. What are the most important factors to evaluate the bank's service area and to assess the number of credits deliverable? Please consider the factors you may add into the ranking. The number 1 represents the most important factor.

Factors	Ranking of importance		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Species distribution	1	1	54%	50%
Presence of endangered/ threatened species	2	2	82%	75%
Habitat diversity occurrence	3	3	54%	75%
Site connectivity	4	4	45%	50%
Range of ecosystem services delivered	5	5	73%	50%
Site condition	7	7	64%	75%
Site restoration or creation	6	6	54%	75%
Other factor:	8	8	91%	75%

Other factors mentioned by bankers:
-Critical habitat provided
-Distribution of species (or the species primary habitat) on the property. The more widespread the more credits you get.
-Location
-Species natural range and distribution
-Distribution of species
- For wetlands the USACE uses a functional assessment tool such as CRAM to assess the "functional uplift" of restored habitats. This determines the credit value for that habitat.
-Watershed proximity
-Regional benefit to species

Other factor mentioned by agency staff:
-Potential site uplift
-Species dispersal range
-Land with restoration potential
-Economic considerations
-Ensuring services area sufficiently sized to offset all losses of function/condition within its limits

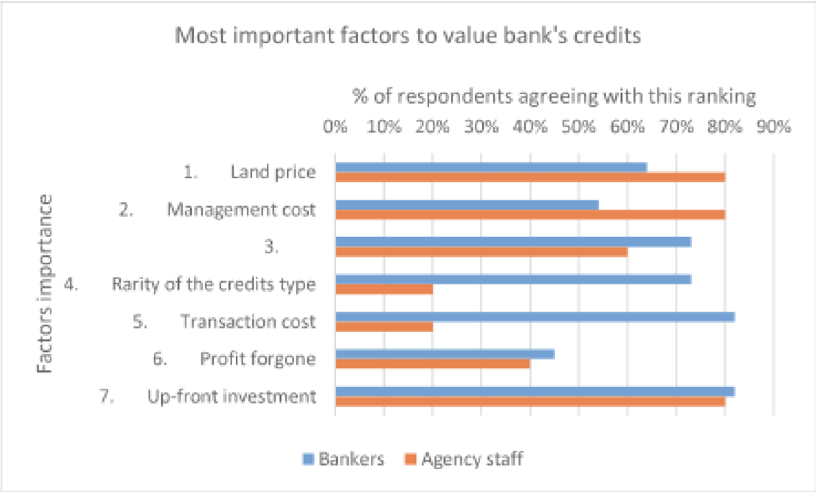


11. What are the most important factors to value the bank's credits in monetary terms? Please consider the factors you may add into the ranking. The number 1 represents the most important factor.

Factors	Ranking of importance		Percentage of respondents supporting banker's priority	
	Bankers	Agency staff	Bankers	Agency staff
Land price	1	2	64%	80%
Management cost	2	3	54%	80%
Rarity of the type of credits	3	5	73%	60%
Transaction costs	4	6	73%	20%
Profit forgone	5	4	82%	20%
Up-front investment	6	1	45%	40%
Other factor	7	7	82%	80%

Other factors mentioned by bankers:
-The actual cost of an applicant to provide his own mitigation
-Supply/demand
-Supply/demand and competition
- Service area

Other factor mentioned by agency staff:
- Species biology will determine the type and number of credits (breeding habitat versus foraging habitat)
- Site contribution to watershed/landscape, condition and potential to address environmental threats
- Willing land owners wanting to do a mitigation bank



References

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