GOOD PRATICE HANDBOOK FOR REVEGETATION IN NATURA 2000 SITES

MATERIALS AND METHODS FOR THE PLAYERS IN THE SUPPLY CHAIN

RestHAlp

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PREFACE

Habitat degradation due to human activities, to hydro-geological instability or to the invasion of alien species, calls for effective solutions tailored to the ecological context, transcending borders as well as pooling resources and expertise to promote coordinated actions in the alpine bio-geographical zone.

RestHAlp - The Ecological restoration of habitats in the Alps - is a project funded by the EU cross-border cooperation programme between France and Italy Interreg ALCOTRA 2014-2020, objective 3.2 *Biodiversity - Improving the management of habitats and protected species in cross-border areas*.

The project started in 2017 and ended in 2020: it was implemented in the Aosta Valley, and in the Hautes Alpes, Isère and Savoy French Departments. The project was promoted by a cross-border partnership of six bodies & authorities- three Italian and three French - matched both in terms of skills and detailed knowledge of the field and the players involved.
The Institut Agricole Régional was the lead partner and coordinated the implementation of the project, which was carried out together with the Conservatoire Botanique National Alpin (F), the Conservatoire d'Espaces Naturels de Savoie (F), the Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (F), the Gran Paradiso National Park (I) and the Autonomous Region of the Aosta Valley, Struttura Biodiversità e aree naturali protette (I).

The overall aim of the project was to contribute to the preservation of natural habitat balance or, where necessary, to restore areas that had suffered from degradation. There were three approaches that completed each other: as well as practical and technical achievements, actions were performed to raise awareness and involve the public in the conservation and habitat enhancement in areas of high natural value.

Assessing and Promoting Ecosystem Services

A shared Action Plan was developed to enhance and promote the ecosystem services offered by protected areas, to promote them to the population and local administrations, providing tools for protected area managers. Seven sites were equipped to measure the services provided by the wetlands (which will continue to provide data after the end of the project), a conference was organised on the subject, and a methodological handbook for the evaluation of ecosystem services was drawn up, as a tool for protected area managers.

Limiting the spread of invasive alien species

Invasive alien species are considered one of the main causes of habitat deterioration and biodiversity impoverishment. The fight against their spread started with monitoring, mapping and studying the dynamics of the spread of the most dangerous species in the territories concerned. The AlienAlp smartphone app was created. It allows reporting of invasive alien species to the plant databases

of the project areas - primarily the Valle d'Aosta Biodiversity Observatory - implemented and updated as part of the project itself and made accessible to the public. In addition, the app proves to be a useful tool to raise awareness and involve the public in reporting and combating invasive alien species.

Develop tools for sustainable ecological restoration

Another aim of the project was to introduce the managers of the Natura 2000 sites and landscape professionals to ecological restoration good practices in degraded natural environments using local seeds. On both sides of the Alps, there have been numerous environmental projects to restore pre-existing ecological conditions; some sites have been the subject of demonstration visits on restoration techniques, aimed at staff in the sector.

The experience gained during the project informed this handbook, which is intended as a tool to disseminate restoration skills, knowledge and methods tested during the project to those directly involved in land management: managers of protected areas and Natura 2000 sites, administrators, farmers, professionals and executing companies.

We would like to thank the ALCOTRA Programme, not only for the substantial financial contribution to the project activities, but also for having created the opportunity for a range of bodies and authorities operating in similar contexts and on similar issues to cooperate: without their support we would have not had the chance to work together. The added value of a cross-border project was not limited to sharing national knowledge and the development of tools, but also sharing of different approaches, points of view and operational strategies, made possible by like-minded people working in different contexts coming together.
Partners consider that the experience developed in the course of the project as a key enrichment of their own expertise, thanks to the integration, the harmonization of approaches, and knowledge sharing.

INTRODUCTION

Alpine meadows and pastures make livestock farming in the mountains possible. They contribute to the beauty of the Alps' landscape turning the environment into a tourist attraction. Likewise, grasslands are of great natural value, because they harbour biodiversity and the presence of endemic and rare species and offer ecosystem services in many ways.

The wealth of services provided by these ecosystems must be maintained and preserved through grazing and traditional agricultural activities. Alpine grassland areas are especially fragile due to their special site conditions and to climate change that can reduce their resilience to possible elements of disturbance.

Globally, the destruction, deterioration and fragmentation of habitats and the spread of Invasive Alien Species (IAS) are considered the two main causes of loss of animal and plant biodiversity. In the Alps, the risks arising from human activities are compounded by the effects of climate change, given that mountain ecosystems are considered particularly vulnerable to the latter.

The signatories to the Nagoya Protocol (2010), including the European Union, called for direct measures to conserve and, where necessary, restore biological diversity and ecosystem services, build capacity, create and share knowledge.

The partners of the RestHAlp project intend to implement these principles in border regions with comparable conditions: degradation of certain habitats - due to agricultural pressure, tourism, spread of invasive alien species - and the need for solutions tailored to habitats and context, offsetting the lack of indigenous seeds and difficulties in monitoring a large and harsh area.

The RestHAlp project aims to preserve or restore the preservation status of natural habitats in the Natura 2000 sites, focussing on wetlands and high altitude grasslands, using methods to restore degraded natural environments, promoting the reconstitution of charac-

teristic flora, fighting against the spread of exotic plants and reseeding with native local seeds.

This guide is intended to be a means to disseminate technical-scientific knowledge and methods for environmental restoration: it is aimed at managers of natural preservation areas and the Natura 2000 sites, to professionals working in land management and to farmers, as well as to the officials who commission, verify and approve environmental restoration projects and planners working in Natura 2000 network territories, in order to help them address problems related to habitat preservation and fighting the spread of invasive species.

The environmental restoration of damaged or disturbed sites in areas of high natural value requires using native local plant material, obtained from seed collections in species-rich permanent grasslands and pastures. Mixed seeds collected in ecologically similar sites to those to be restored gives positive results in the preservation of biodiversity, accelerating restoration times and increasing the capacity of the vegetation cover to take and grow.

The RestHAlp project follows on from previous projects by its partners (Alp'Grain and NAPEA), further developing the practical tools for the implementation of the network. Specifically, source areas for the territory concerned have been identified, consistently with Directive 2010/60/EU, as have the next practical steps and the implementation costs.

ECOLOGICAL RESTORATION
OF NATURAL AND SEMI-NATURAL GRASSLANDS IN THE NATURA 2000 NETWORK

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The Natura 2000 network

The Natura 2000 network, established in 1992 by the 92/43/EEC Habitats Directive, is the main instrument for the preservation of animal and plant biodiversity within the European Union. It consists of an ecological network covering the entire Union, aimed at ensuring the maintenance of natural habitats and threatened or rare flora and fauna species in the Community.

The network consists of the Sites of Community Importance (SCI) identified by the Member States according to the provisions of the Habitats Directive, and designated as Special Areas of Conservation (SAC), and also includes the Special Protection Areas (SPA) established in accordance to Directive 2009/147/EC Birds for the preservation of wild birds.

Basis and concepts of ecological restoration

This chapter lists and details the basis of ecological restoration.
There are many albeit incomplete definitions of «ecological restoration» in literature[1]. This handbook will use the term referring to **active preservation of biodiversity in returning the ecosystem to a condition prior to damage.**

Ecological restoration is the process that begins or assists and hastens the recovery of an ecosystem that has been degraded, damaged or destroyed[2]. Often this term is used to indicate not only a process, i.e. the activities undertaken, but also the expected result: assisting the ecosystem on a path of recovery so that

it can be preserved, and its species can adapt and evolve.
In current terminology, «ecological restoration» can also be referred to as «environmental restoration", «ecological recovery», «environmental recovery», «environmental upgrading», «ecosystem rehabilitation». For the purposes of this handbook we will consider them as synonyms, since they share the same purpose: the restoration of plant cover on areas affected by damage caused by natural – such as landslides, debris flows, floods...- or human causes – such as excavations, land improvement, securing slopes and escarpments, construction of ski slopes...), from the valley floor to the alpine level.
Such actions are required whenever the plant cover is degraded as a result of:

- presence of invasive alien species;
- soil movements of the ground such as excavation, earthwork, storage of materials, and so forth;
- surface erosion of natural origin such as surface water runoff, landslides, flooding, etc.;
- surface erosion due to human activities such as incorrect pasture management with excessive trampling of livestock, areas adjacent to scarcely or unmarked paths, and so forth.

Ecological restoration of wetlands

This section refers to the definitions extensively detailed in the literature on the ecological restoration of aquatic environments and, more specifically, related to watercourse. Such definitions are also applicable to the specific characteristics of wetlands.

ECOSYSTEM TRAJECTORY

The wetland ecosystem evolves spontaneously following trends that can be progressive, cyclical or event driven. This long-term evolution, or «ecosystem tra-

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jectory» includes slow transformations and moments of drastic change. It can be natural, that is due to climate, geomorphology, biology, etc. or anthropogenic. When there is a balance, the mechanisms of adaptation to the main disturbances (resilience) enable the stability of conditions favourable to the ecosystem to develop.

REFERENCE STATE

A reference state or function can be termed as a «good ecological state» although this is impossible to do so in absolute terms. However, to assess whether one has achieved restoration targets, the following need to be defined:

- the target of the state to be achieved, determined using a range of criteria, based on general scientific knowledge, but also on measurements on neighbouring or similar sites; and
- a reference for comparison, i.e. the evolution or progress in relation to the situation of the ecosystem before restoration.

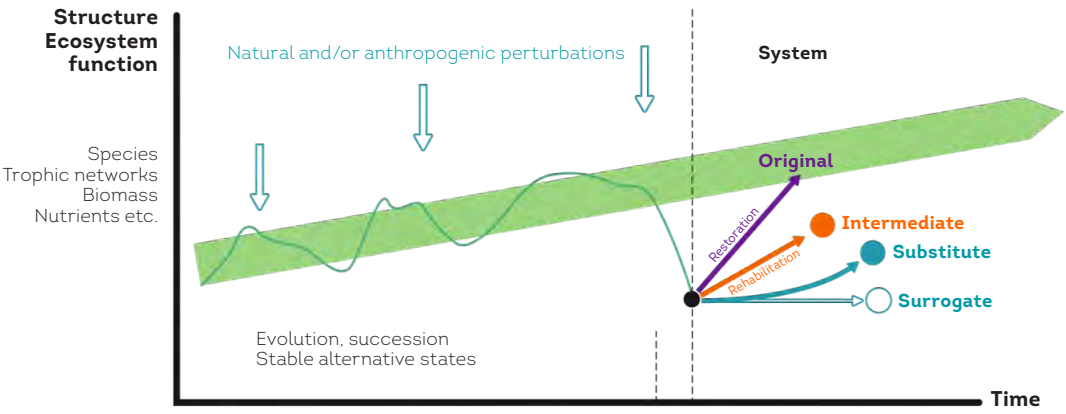
RESTORATION/REHABILITATION

Strictly speaking, restoration means the return of the ecosystem to its original trajectory. Given the different parameters that influence the dynamics of wetlands, today it often seems illusive, if not impossible, to return to the ecosystem to the situation before the damage and therefore achieve a real recovery. From this point of view, the term «rehabilitation" would perhaps be more appropriate, to consider the constraints and historical human distortions that cannot be remedied. An example could be the landscaping and reallocation of alluvial environments (meadows and woods) to a fishing pond once inert materials have been removed from the alluvial terrace.

REALLOCATION / CREATION

When it is impossible to return ecosystem to its former state, actions lead to the creation of a new one. In that case we speak «reallocation» or «creation» of a new ecosystem. The substitute, or surrogate, ecosystem may have an equivalent value to the pre-existing ecosystems although it differs in nature as, for instance, the oxbow lake recovery in the old course of the River Rhône by triggering old hydraulic and fish connections as well as improving the local defined outflow.

ECOSYSTEM FUNCTIONS IN RESPONSE TO TIME AND PERTURBATIONS



Adapted from Porteret *et al.*, 2017.

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Preservation materials

Research on the ecology of restoration highlights the importance of using locally sourced seed to avoid possible risks associated with the introduction of non-native or alien[3] plants, which may be either unsuitable for the environment which they are introduced in, or may hybridise or compete with local flora or may even disrupt interactions with other organisms if their breeding cycles differ from those of locally sourced plants.

Native seeds come from non-selected plants naturally present in the same bio-geographical area as the area to be restored. This means they are suited to the bioclimatic conditions of the environment where they will be sown. They can be obtained by mixing seeds produced in propagation fields, from plants grown from seeds gathered in the collection site and grown in purity. Alternatively, the preservation material can be obtained from a mixture of seeds collected in meadows and pastures, with or without cleaning such as green grass, hay, and brush harvested seeds hay-flower. Preservation material must be gathered in specific areas *(source areas)* for revegetation in an area of high natural value subjected to ecological restoration.

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Source areas

Source areas characterised by a specific habitat are identified by the competent authorities, within the Natura 2000 network. In these areas, sites for the collection of preservation material must be identified: they must not have been re-seeded for at least 40 years. In Italy and France, source areas are:

- the Special Areas of Conservation (SAC);
- Special Protection Areas (SPA), areas that contribute to the preservation of genetic plant resources and are managed, protected and monitored as SAC.

Supply chain players

In the supply chain there are both **external** players- those who create the conditions for the implementation of the preservation material supply chain, support it over time and control its activity - and **internal** players, directly involved in the production of preservation material.
Below are the players involved in the area covered by the RestHAlp project.

PLAYERS INVOLVED	AOSTA VALLEY	FRANCE
Managing body of the Natura 2000 network sites	Autonomous Region of the Aosta Valley Gran Paradiso National Park (PNGP) Mont Avic Natural Park (PNMA)	DREAL Auvergne Rhône-Alpes DREAL Provence-Alpes-Côte d'Azur[4]
Planning	Technical Departments of public bodies (Regions, Municipalities, ANAS[5] and so forth. Private technical offices - managing power lines, waterworks, gas pipelines, ski slopes and the like	Natura 2000 site Management Planning Authority
Designing	Public and private technical offices Technical experts	Natura 2000 site Management Planning Authority
Gathering preservation materials	Farmers	Varies greatly according to the context: businesses, farmers, seed companies, managers of natural areas, etc.
Carrying out the work	Private enterprises Workers from public agencies and authorities (Regions, Municipalities, ANAS)	Varies greatly according to the context: businesses, farmers, managers of natural areas, etc.
Supervision and direction of work	Site manager: a technical expert appointed by the planners	Site manager
Monitoring and overseeing	Aosta Valley Forestry Corps PNGP and PNMA rangers	Competent DREAL

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Invasive Alien Species (IAS)

There are different definitions of invasive alien species; the European Union defines them as species of animals, plants, fungi or microorganisms outside their natural area, the spread of which threatens or has adverse effects on related biodiversity and ecosystems[6]. By entering into direct competition with some of the local species, they can alter the state of natural habitats and cause economic damage to agro-silvo-pastoral (farming, woodland and animal husbandry) activities.
In order to prevent or mitigate the negative effects of the introduction and spread of IAS, the EU adopted Regulation 1143/2014 and periodically publishes the list of species considered of Union importance, i.e. those whose negative effects require concerted action at Union level. This list was updated in 2016, 2017 and 2019, now includes 66 species.
Actions are based on: prevention, early detection and rapid eradication, and management, in the case of species that have already widely spread.
In the Aosta Valley alien plant species subject to monitoring, containment or eradication were identified by Regional Law 45/2009 and subsequent modifications and additions.
France has had regulations on invasive alien fauna for some time, while the first national legislation on invasive alien plants, concerning only two species of water primrose *(Ludwigia spp.)* found in mainland France, dates back to 2007. The 2014 EU Regulation was incorporated with a ministerial decree on the prevention of the introduction and spread of IAS in mainland France (2018). Lists of IAS were defined at regional level. In the case of the Auvergne-Rhône-Alpes and Provence-Alpes-Côte-d'Azur Departments, the two administrative regions of the French Alps, the *Conservatoire Botanique National Alpin* has classed alien plants as potential, certain or emerging invasive, on the basis of their current distribution, the type of habitat occupied and their known impact. Lists do not entail any obligation but may serve as a basis for actions related to IAS management.

Regulatory framework and preservation mixtures

The current regulatory framework for the marketing of preservation mixes is as follows[7]:

EUROPEAN UNION Directive 2010/60/UE	Providing for derogations for the marketing of fodder plant seed mixtures intended for the preservation of the natural environment.
ITALY Decree 148/2012	Implementation of Directive 2010/60/EU on derogations for the marketing of fodder plant seed mixtures intended for the conservation of the natural environment (12G0169).
FRANCE Decree 24/01/2012	Act on the marketing of seed mixtures of fodder plants intended for the preservation of the natural environment.

Most of the species used in revegetation are subject to compulsory certification, i.e. the seed produced must come from selected varieties registered in the official catalogue. Directive 2010/60/EU introduced the possibility of producing and marketing local seeds for species requiring compulsory certification by way of derogation and for environmental preservation purposes.

The current legislation lays down the following rules:

Definition	'Preservation seed mixture' comes in two types: • directly harvested seed mixtures, consisting of a seed mixture marketed as gathered, with or without cleaning; • cultivated seed mixtures, obtained by mixing seed produced in propagation fields, from seed grown plants taken from the collection sites and grown in purity.
Place of collection	**Collection sites** must be within the **source areas**, designated nationally as Special Areas of Conservation (SAC) or as areas contributing to the preservation of plant genetic resources and within the **regions of origin**, with which the mixture is naturally associated and which may also include trans-border territories. Collection sites must not have been reseeded for at least 40 years and must be from a specific habitat.
What is collected	Directly harvested seed mixtures must meet specific technical standards to recreate the habitat of the collection site, such as an appropriate percentage of components and germination rate, a low content of species or subspecies not characteristic of the habitat, a low content of Rumex spp. and the absence of certain weeds such as *Avena fatua, A. sterilis* and *Cuscuta* spp. The cultivated seed mixture, consisting of seed collected in purity and subsequently blended, must meet the commercial requirements of the relevant Directive as regards specific purity for fodder plants and maximum seed content for other plant species.
Where can it be used	Mixtures are intended for the preservation of the natural environment in the context of the conservation of genetic resources in the region of origin, i.e. the territory which the mixture is naturally associated to.
Marketing conditions	Mixtures must be stored in closed packaging or containers, specially sealed and labelled by the producer with the indication "Preservation fodder plant seed mixture, intended for use in an area with the same habitat type as the collection site, not considering the biotic conditions".
Who can market these seeds	Any producer authorised by a body designated by the Member State (CRA-SCS for Italy and CTPS for France).

Mixture marketing for preservation is allowed only if aimed at the conservation of the natural environment and in the context of the preservation of genetic resources, as expressly stated in Article 2 of Directive 2010/60/EU and in the national laws that have incorporated it.
Currently, both in Italy and France there are no rules requiring the use of local native seeds for revegetation. The only legal instruments that specify obligations to use seed suited to the environment are:

- **preservation measures** for Natura 2000 network sites, aimed at the maintenance or restoration of natural habitats and species present there; and
- **park management plans,** that is the planning tools for protected areas.

To date, in France only a few preservation mixtures containing -compulsorily- certified species have been registered and allowed to be produced. Production by multiplication of local seed is still mainly limited to non-certified species[8]. The *Végétal Local* collective label, established in France, guarantees the local origin and diversity of the seeds produced. Lastly, seed mixtures can be gathered directly in-house or contracted out when the seeds are collected in areas close to the sites of use.

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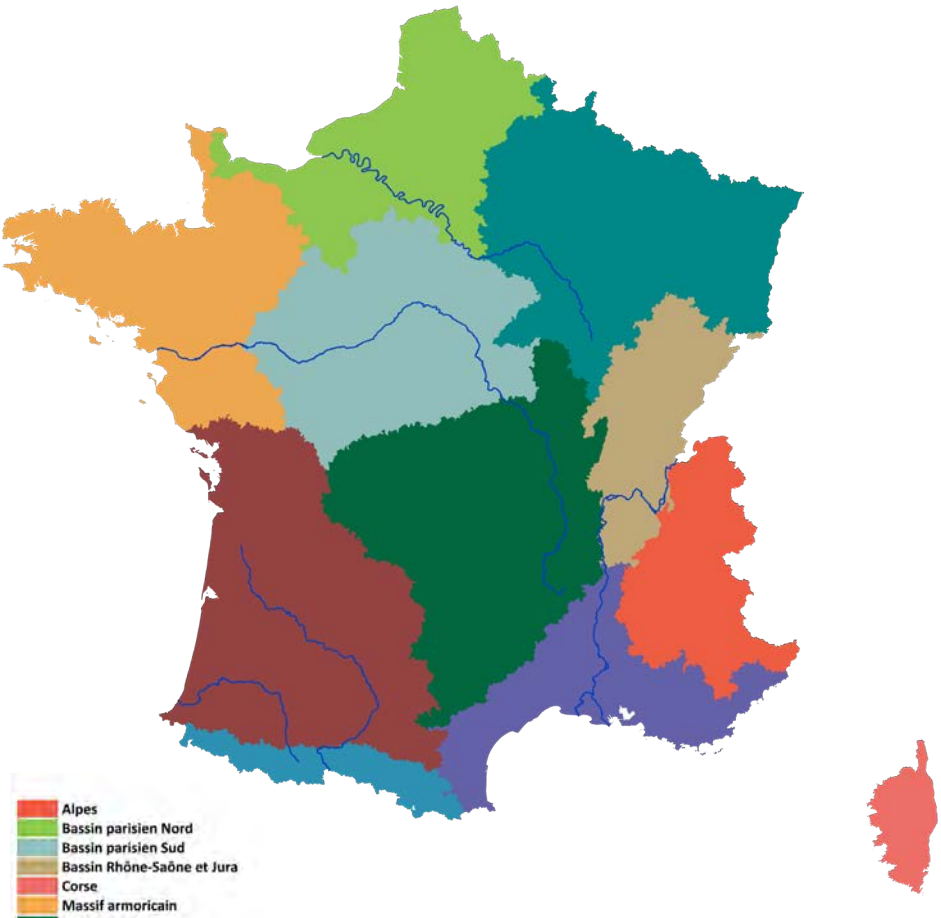
Végétal local

Végétal local is a simple collective trademark, registered at the *Institut National de la Propriété Industrielle* (INPI) and belongs to the Office français de la biodiversité (OFB).
The procedural guideline guarantees three main values: **conservation** (of the local genetic heritage), **diversity** (intra- and interspecific) and **traceability** (warranty of the local and spontaneous origin of the seeds).
The brand is based on the map of the regions of origin to guarantee the traceability of the origin at all stages of harvesting, production and marketing.



The Végétal local label applies to all spontaneous plants of local origin (coming from a region of origin) with the exception of protected or rare species and horticultural, forage, agricultural or selected species.

www.vegetal-local.fr

MATERIALS TO SUPPORT
SUPPLY CHAIN DEVELOPMENT

This chapter aims to provide those in the supply chain with useful information and operational tools for the use of preservation mixtures.
In order to organise the supply and use of seed for preservation, the areas where the material is gathered must be identified, considering the habitat to be recovered.
As part of the RestHAlp project, two fundamental tools have been developed: for those who have to identify the sites to collect material for preservation, a geo-referenced database has been created to choose a source area according to the ecological and environmental similarities with the destination areas. Moreover, specific cartography makes it possible to verify the spread of IAS, both in the areas surrounding the collection sites and in those under recovery, in order to provide adequate containment measures. The AlienAlp smartphone application performs periodic updating of maps and databases, benefiting from users' data input.
Once the collection sites have been identified, supply chain players must apply for authorization and pay compensation to the owners or tenants of the holdings to brush or mow. As a tool to facilitate procurement practices, we calculated the cost of supplying and using the preservation material for ecological restoration, identifying the items which in the Aosta Valley the Region can include in the *Price list for public works of regional interest* referred to in Article 42 of Regional Law No 12 dated 20 June 1996, with subsequent amendments and additions.
Planners need to identify methods procedures and the work to be carried out for recovery. This is why we identified a working method which allows planning the tasks from design to subsequent maintenance, focusing on the main types of restoration.
While pursuing the common aim of developing the supply chain, it is crucial to understand that a common cross-border procedure cannot be drafted, since the ones performing the different functions differ on the two sides of the transalpine border and cover different roles.
Finally, it is possible to evaluate the results of ecological restoration using the ASPIRE method, developed in the framework of the project and which is illustrated below.

Mapping the distribution of IAS

Having a good grasp of IAS distribution is essential to contain their spread, not only in view of the ecological restoration of a degraded site, but as prevention, for the agronomy and engineering planning in the event of excavation and filling. Those who plan and design ecological restoration can prevent or limit soil removal in infested areas and fine-tune the most appropriate actions to contain the spread of these species.

The swift spread of IAS requires setting up a dynamic investigative tool that can be quickly updated. Thanks to the RestHAlp project, the distribution of three species requiring special attention *(Heracleum mantegazzianum, Reynoutria bohemica, Senecio inaequidens)* has been mapped and the data have been used as the basis for the creation of the AlienAlp app. The App enables citizens to identify IAS and report their presence. Following valida-

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tion by experts, data are registered in the Aosta Valley, Piedmont and the French Alps flora databases, keeping them constantly updated.

The App will be subsequently extended to include other species from the blacklists of the areas involved in the project. Currently it enables to report the presence: *Ailanthus altissima, Ambrosia artemisiifolia, Buddleja davidii, Heracleum mantegazzianum, Reynoutria bohemica, Senecio inaequidens,* and *Solidago gigantea.*

Identification of source areas

When planning a restoration action, it is important to know the areas where to collect seeds, depending on the herbaceous communities and site locations.
The aim is to identify the grasslands in the Natura 2000 network suited for seed harvesting. All potential collection sites must meet the following requirements:

- be herbaceous plant communities;
- be listed in the Natura 2000 network;
- not have been reseeded or restored with commercial seed - e.g. as a result of disruptions, flooding events, excavation works, etc.

In addition, in the event of mechanical harvesting by brushing or mowing, sites must be accessible by farm vehicles, so adjacent to roads or tractor tracks, nearly flat -with a gradient below 25% - and with no obstacles such as outcropping boulders, canals or streams, areas of excessive water stagnation that reduce the ground's carrying capacity.

Maps of potential source areas developed within the RestHAlp project and the methods can be found on the websites of the project partners.

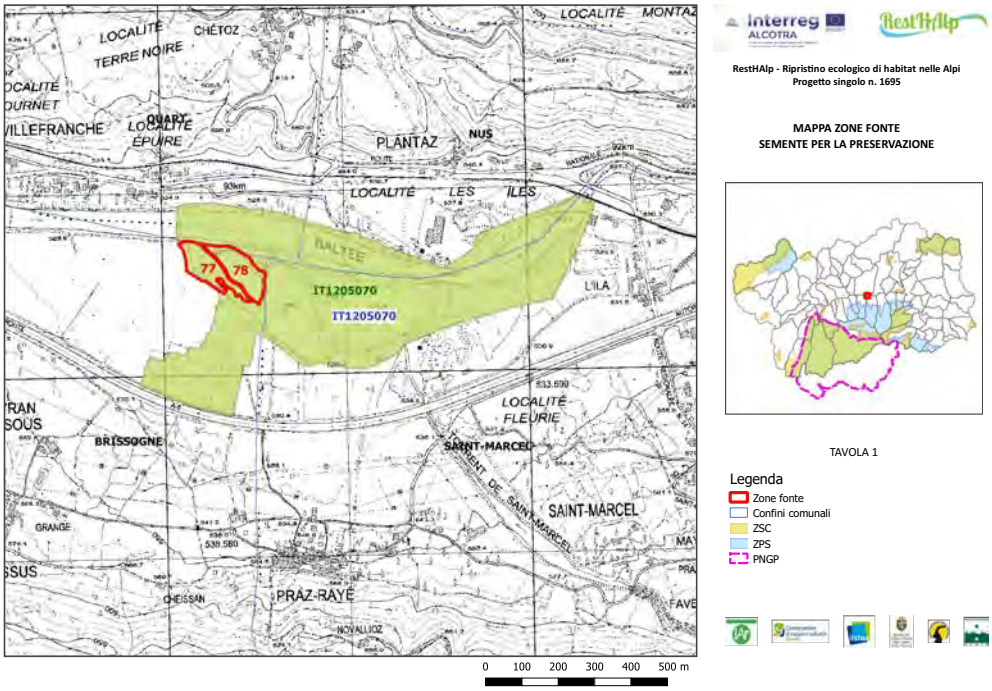
Aosta Valley

The catalogue of the potential areas for collection of preservation material was based on the maps of the habitats included in the Natura 2000 network made available by the Autonomous Region of the Aosta Valley and the Gran Paradiso National Park (PNGP). Thanks to a GIS analysis of the environment and field validation inspections, more than 280 hectares for the mechanical collection of preservation material in the Aosta Valley have been identified. A number of external plots totalling about 23 hectares, bordering the Natura 2000 areas, were also included, their flora making them specially well suited to the collection of seeds for environmental restoration.

The areas identified are as follows:

NATURA 2000 SITES AND MUNICIPALITIES	SURFACE (ha)
IT1201000 - Parco Nazionale Gran Paradiso	**95.24**
Valsavarenche	*82.05*
Cogne	*11.88*
Aymavilles	*1.31*
IT1202000 - Parco naturale Mont Avic	**2.97**
Champorcher	*2.97*
IT1202020 - SPA Mont Avic-Monte Emilius	**94.53**
Saint-Marcel	*72.08*
Charvensod	*10.82*
Fénis	*5.82*
Issogne	*5.81*
IT1203050 - Lago di Villa	**0.72**
Challand-Saint-Victor	*0.72*
IT1204030 - SPA Val Ferret	**9.32**
Courmayeur	*9.32*
IT1204032 - Talweg della Val Ferret	**13.53**
Courmayeur	*13.53*
IT1205020 - Ambienti d'alta quota del Colle del Gran San Bernardo	**31.27**
Saint-Rhémy-en-Bosses	*31.27*
IT1205070 - Zona Umida di Les Îles di Saint-Marcel	**2.22**
Quart	*1.15*
Brissogne	*1.07*
IT1205081 - Ambienti calcarei d'alta quota attorno al Lago Tsan	**1.00**
Nus	*1.00*
IT1205082 - Stagno di Lo Ditor	**0.89**
Torgnon	*0.89*
IT1205090 - Ambienti xerici di Grand Brison-Cly	**8.94**
Saint-Denis	*8.94*
Areas adjacent to but outside the Natura 2000 network	**23.16**
Rhêmes-Notre-Dame	*15.96*
Cogne	*7.20*
Total	**283.79**

More details of the listed areas, broken down by site, municipality and relevant habitat, can be found on the website of the *Institut Agricole Régional*: www.iaraosta.it.



The database enables users to identify the areas where to gather the seed according to the habitats to be restored: it is a dynamic source of information, which can be further enriched and modified by the Site Bodies over time.

Once identified the source area suited to the type of habitat to be restored, land titles have to be checked to request authorization to gather. References can change because of inheritance, sales, property splitting, has not been recorded in the source area database, but the data in *shapefile* format allows a quick consultation by accessing the land registry database available to the Bodies and professionals in WMS format[9].

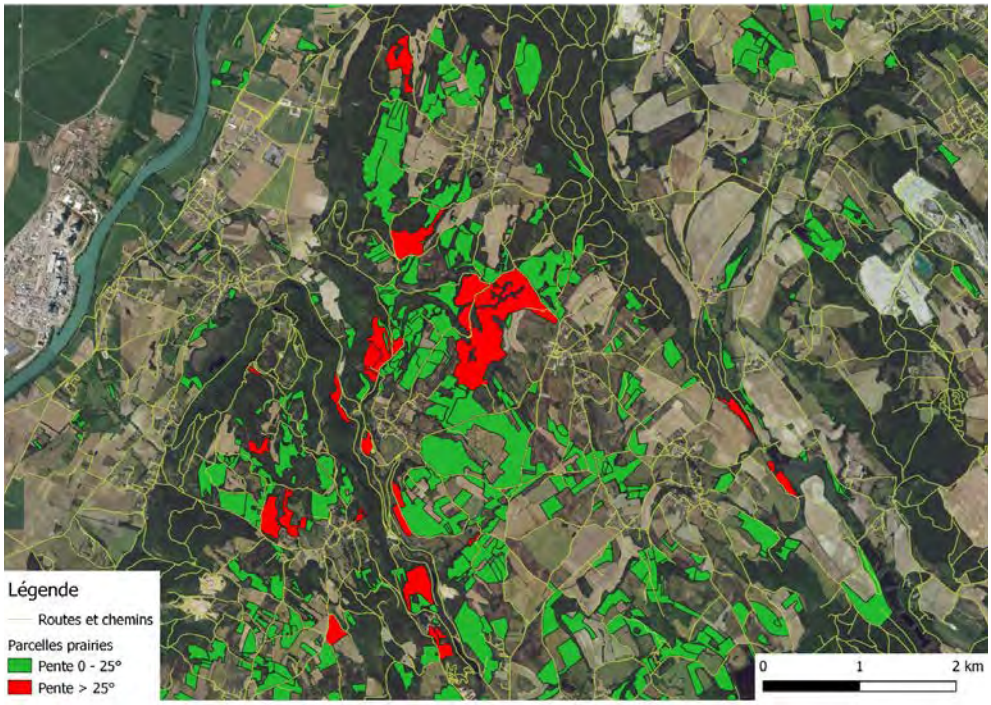
France

The territory on the French side includes the three departments of the northern Alps: Haute Savoie (74), Savoie (73) and Isère (38). The map base used is the *Registre Parcellaire Graphique* (RPG), which lists all the agricultural parcels in France, and those corresponding to meadows ('*Prairie en Rotation Longue*' and '*Prairie Permanente Herbagère*') included in the Sites of Community Interest have been selected. Plots with a maximum gradient exceeding 25% were discarded, as it is considered that seed collection is more difficult or even impossible, depending on the method used but especially with a pull-type seed harvester. All information related to the *Regulated natural areas*, that is national and regional nature reserves, national parks, biotopes protected by prefecture decree, is linked to each polygon. Finally, areas under 100 m^2 have not been counted.

Results show that over 5,600 hectares are potentially available for the local seed collection in SCIs, 3,880 of which in Isère, 1,100 in Savoy and 656 in Haute Savoie.

SCI BY DEPARTMENT	SUPERFICIE (ha)
Isère	**3,880.76**
FR8201638 - Milieux alluviaux et aquatiques du fleuve Rhône, de Jons à Anthon	2.91
FR8201653 - Basse vallée de l'Ain, confluence Ain-Rhône	0.16
FR8201726 - Étangs, landes, vallons tourbeux humides et ruisseaux à écrevisses de Chambaran	82.71
FR8201727 - L'Isle Crémieu	2,801.76
FR8201728 - Tourbière du Grand Lemps	133.22
FR8201729 - Marais du Val d'Ainan	87.59
FR8201736 - Marais à Laiche bicolore, prairies de fauche et habitats rocheux du Vallon du Ferrand	6.20
FR8201738 - Plaine de Bourg d'Oisans	440.06
FR8201742 - Marais - tourbières de l'Herretang	124.94
FR8201745 - Pelouses, forêts remarquables et habitats rocheux du Plateau du Sornin	20.86
FR8201747 - Massif de l'Obiou et des gorges de la Souloise	27.16
FR8201749 - Milieux alluviaux et aquatiques de l'Ile de la Platière	0.38
FR8201751 - Massif de la Muzelle en Oisans - Parc des Écrins	19.78
FR8201753 - Fôrets, landes et prairies de fauche des versants du Col d'Ornon	133.03
(Savoy) Savoie	**1,097.79**
FR8201770 - Réseau de zones humides, pelouses, landes et falaises de l'avant-pays savoyard	131.59
FR8201771 - Ensemble lac du Bourget-Chautagne-Rhône	243.85
FR8201772 - Réseau de zones humides de l'Albanais	147.43
FR8201773 - Réseau de zones humides dans la Combe de Savoie et la moyenne vallée de l'Isère	132.62
FR8201774 - Tourbière des Creusates	0.45
FR8201775 - Rebord méridional du Massif des Bauges	34.61
FR8201777 - Adrets de Tarentaise	197.63
FR8201779 - Formations forestières et herbacées des Alpes internes	57.69
FR8201780 - Réseau de vallons d'altitude à Caricion	0.24
FR8201781 - Réseau de zones humides et alluviales des Hurtières	73.95
FR8201782 - Perron des Encombres	5.48
FR8201783 - Massif de la Vanoise	42.06
FR8202002 - Partie orientale du Massif des Bauges	20.55
FR8202004 - Mont Colombier	9.64
Upper Savoy (Haute-Savoie)	**656.31**
FR8201698 - Contamines Montjoie - Miage - Tré la Tête	3.88
FR8201700 - Haut Giffre	6.42
FR8201701 - Les Aravis	6.97

FR8201702 - Plateau de Beauregard	0.27
FR8201703 - Massif de la Tournette	1.10
FR8201704 - Les Frettes - Massif des Glières	25.53
FR8201705 - Massif du Bargy	3.74
FR8201706 - Roc d'Enfer	14.41
FR8201707 - Plateau de Loëx	13.68
FR8201708 - Mont de Grange	0.45
FR8201709 - Cornettes de Bise	0.13
FR8201711 - Massif du Mont Vuache	167.96
FR8201712 - Le Salève	178.62
FR8201715 - Vallée de l'Arve	5.14
FR8201718 - Les Usses	2.12
FR8201720 - Cluse du Lac d'Annecy	17.81
FR8201722 - Zones humides du Bas Chablais	69.48
FR8201723 - Plateau Gavot	13.14
FR8201724 - Marais de Chilly et de Marival	15.34
FR8201772 - Réseau de zones humides de l'Albanais	31.73
FR8202002 - Partie orientale du Massif des Bauges	11.89
FR8202009 - Lac Léman	66.50
Total	**5,634.86**



What to check before collecting preservation materials?

After consulting the map of the potential Source Zones, check the following:

Ecological matching of the collection area and the area to be restored
Verify matching in terms of natural habitats comparing the collection area to the area to be restored, and in particular define a reference ecosystem and what species are involved. Which habitat do we want to restore: a hay meadow in the mountains? A wet meadow on the hills? A dry grassland?

Protected species and IAS
Verify the presence of both protected and invasive alien species using available databases, such as the Aosta Valley Regional Observatory for Biodiversity. In France there are systems such as SINP *(Systèmes d'Information Nature et Paysage)* in each region (for example PIFH, *Pôle d'Information flore-habitats-fonge* in Auvergne Rhône-Alpes). To get a first idea of the presence of IAS, you can also use the AlienAlp App. However, since the information available in the database is not exhaustive, it is essential to make a floristic survey of the plot before gathering.
In the presence of these species, the collection of seeds on the plot is forbidden.

Altitude difference between the collection area and the area to be restored
This parameter should be considered before any environmental restoration work, as seeds must be harvested in areas with comparable bioclimatic conditions.

Distance between the collection area and the area to be restored
The seeds for ecological restoration must be locally sourced. Potential source areas should be included within a limited radius around the recovery area, roughly 10 km.

Authorisation documents and collection specifications

Aosta Valley

Before proceeding with the collection of the preservation material, authorization from the owner or the tenant is required, formalizing it through a private contract.

During the experimental collection operations part of this project, a facsimile model of the specifications was drawn up for the private contract of authorisation, detailing the areas to be collected, the conditions to gather material and the methods of compensation.

France

France has no specific procedure for the collection of wild species seed in the wild, with the exception of legally protected species (Law 76-629 of 10 July 1976) and species with compulsory certificate for the marketing of the seed (Decree of 2 October 2017 on the marketing of fodder plant seed) such as *Dactylis glomerata, Poa pratensis, Trifolium pratense* and so forth.
For the collection of plant material, including that taking place in protected natural areas, the consent of the owner and, if present, of the tenant is required.

Aosta Valley

The collection of preservation material will result in a loss of forage production for the land manager, whether the plant mixture is obtained by brushing or, even more so, mowed grass. Such loss may refer to the amount gathered, because of the removal of all or part of the grass, or even qualitative, since brushing the meadow after seed ripening causes a delay in mowing for fodder.

Adequate refund should therefore be provided to compensate for loss.
We calculated compensation to Aosta Valley farmers analytically, differentiating it according to the technique used (green hay mowing or harvesting the seed with a mechanical brush), the type of grassland (irrigated meadows at an altitude below or above 1500 m, dry meadows, pastures). The price adopted for the different types of harvesting and grassland varies according to local market and the Farm Accountancy Data Network (FADN) economic data.
Productivity refers to the Standard Productions defined by the Aosta Valley Department of Agriculture[10].
As regards hay-flower yield in brush harvesting from grasslands, the data recorded in the Alp'Grain project were used, assuming the values indicated for «hay meadow» for irrigated meadows, both below and above 1500 m asl., applying figures referring to pastures also to dry meadows, as there are no bibliographic data relating to their specific productivity with regards to the collection of seeds with brushing.

Also for the work times related to the brushing of the meadows, reference was made to the Alp'Grain[11] project, while for mowing, reference was made to the portal www.regioflora.ch.
Price analysis was based on the regional Price List, approved by Regional Decree 966/2015 and updated in 2017[12] for labour costs only. For grass and hay prices, reference was made to the FADN Economic Data and to Chambers of Commerce price lists (2019 mean values).

For 2019 values for compensation to farmers were as follows:

	Compensation per grassland type [€/ha]			
Harvest	Irrigated meadows <1500 m asl	Irrigated meadows >1500 m asl	Dry meadows	Pastures
Green hay mowing	300	200	180	150
Brushing	240	160	135	125

France

In France, compensation is agreed on an ad hoc basis with the owners or tenants, taking the price of hay at the time of harvesting into account. In some cases, when the owners or tenants also offer the collection services, an overall price is agreed.

Activity planning

In this section we propose an approach to implement ecological restoration. The players in the supply chain involved in the design and implementation of projects will find instructions regarding the technical-operational methods that make it possible to achieve results compatible with the objectives using adaptive management skills.
Planning activities is key to attaining the set objectives, with a rational use of resources.
Planning choices must start by analysing the level of protection of the degraded site: a comprehensive knowledge of protection priorities serves to modulate and

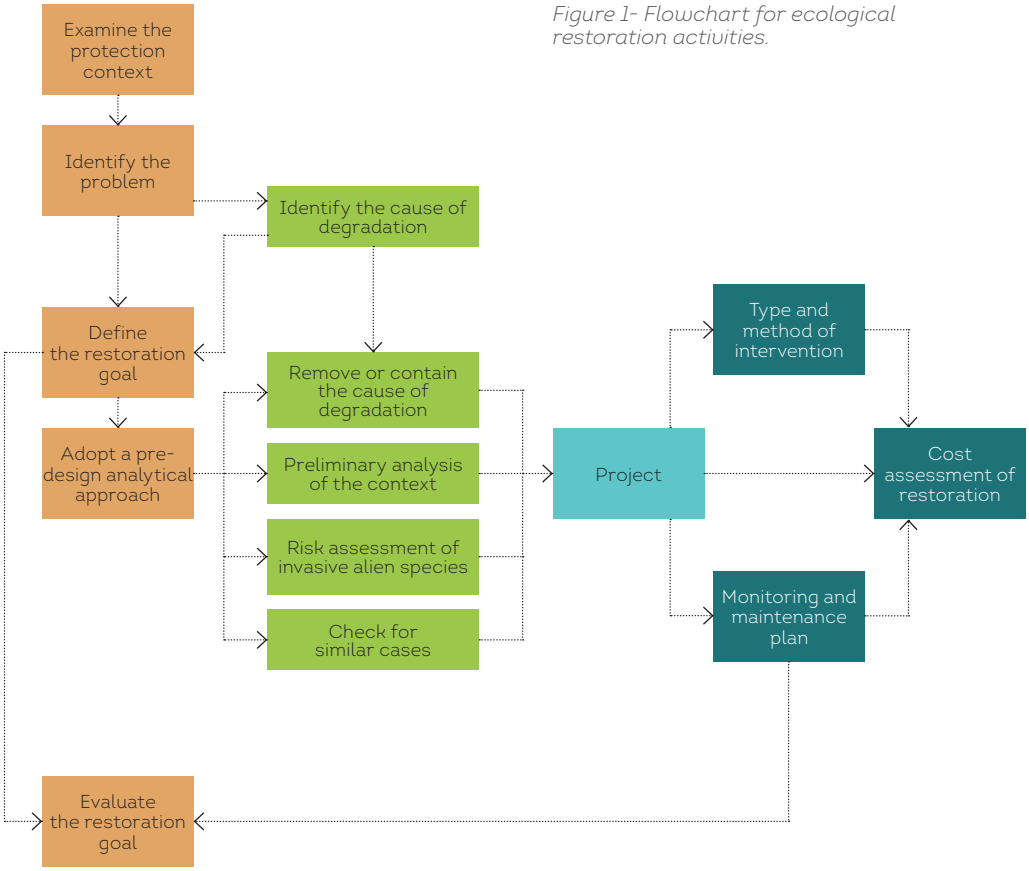


Figure 1- Flowchart for ecological restoration activities.

define planning of the resources to be invested in the design according to the expected result. For instance, the presence of very rare species or of priority habitats, will determine a higher level of protection and a greater commitment to achieve restoration will be required.
Target identification also requires identifying the cause of the degradation and whether it can be eliminated before restoration has been completed: for instance, repeated passage of herds and flocks may be a cause of deterioration that can be contained with more careful animal husbandry.

Once the restoration objective has been selected consistently with the context of protection, the prevailing use of the land to be restored - such as pasture land, ski slopes, road embankments, woodland clearings and so forth - can be identified and the problem solved. The design must be approached starting from a careful environmental analysis by a specialist, for example an Agronomist or Forestry engineer defining at least the following minimum parameters:

- **soil gradient:** to assess the need for consolidation work prior to sowing or measures to limit surface water run-off or water stagnation;
- **altitude:** at the subalpine and alpine level, delicate soil, a short growing season, the persistence of the snowpack and the unavailability of water due to prolonged frost limit paedogenesis and the amount and the type of plants growing;
- **water availability:** to take measures to increase soil moisture levels or to drain any excess water;
- **soil characteristics:** according to the extent of the restoration work and land use, soil testing must be at different levels of depth;
- **plant and landscape context:** the plan must blend ecologically and scenically into the territory;
- **extension and morphology of degraded areas:** actions to restore the plant cover on a small road escarpment will be decidedly different from what is required for the environmental recovery following the laying of a pipe in a meadow, just like the extension of a ski slope requires actions other than the recovery of a meadow in the valley floor damaged by the temporary use as a storage area for materials.

It is essential to verify the presence of invasive alien species, both in degraded areas and in neighbouring sites, to identify methods and timing of actions to counter their spread.
Comparison with similar interventions for degraded habitats, environmental conditions or restoration aims can be useful to calibrate methods according to the results obtained.

Once the pre-project analysis has been completed, it is possible to plan the environmental recovery. *A Monitoring and Maintenance Plan* has to be drawn up for recovery and any work using plant species at the same time as planning.
Environmental restoration design must include the technical specifications relating to the use of preservation material and the estimated metric calculation of the work to be carried out to complete revegetation and to preserve soil horizons (organic horizons - O and topsoil - A).

As in any project, ecological restoration requires a maintenance plan considering the ordinary and extraordinary measures to be carried out in the years to follow. If methodically, rationally organised and planned, maintenance works make it possible to limit costs and increase the effectiveness of the work. The Plan must ensure maintenance over time, guaranteeing functionality, through appropriate planned actions, to counter degradation. Maintenance should also be financially viable, so that implementation is economically feasible. Maintenance activities are classed according to the scheduled intervention:

- ordinary maintenance, performed regularly and periodically;
- extraordinary maintenance aimed at restoring the functionality following exceptional events.

The cost of environmental recovery must include both the estimated costs for implementation and those provided for in the Maintenance Plan. The definition of total costs makes it possible to allocate adequate resources and thus guarantee success.

In carrying out the work, the technical expertise of the companies involved is fundamental, as well as the skill of the technicians who direct the work and verify that the companies apply the correct operating methodology during the site phase.
Recovery must be closely monitored so that lessons can be learned for possible future work and methods adapted if necessary (adaptive management)[13]. Analyses must consider both the general and specific objectives of the project. If the project is evaluated using the ASPIRE method *(Appréciation du Succès des Projets d'Ingénierie et de Restoration Écologique)*[14] it is important, to ask the right questions before starting: who are the main players in the project? What are its objectives? How important is each objective for the various players? Which measurable variables make it possible to judge whether the objectives have been achieved? What weight do these variables have in achieving each objective? To monitor progress achieved with the restoration (i.e. the difference with the previous conditions) and what still remains to be done to reach the goal (i.e. the difference with respect to the baseline target), precise measures of the ecosystems baselines are needed, and the pre-work state has to be clearly identified before the start of the restoration. Observations will be key in assessing the effectiveness of recovery operations. Monitoring must be regular and distributed over time and space. Indeed, although short-term monitoring is essential to fine-tune the management of the rehabilitated site, only long-term monitoring will make it possible to assess the effectiveness of the techniques applied. Similarly, in view of the variability of results and the inaccuracy in evaluating them, several surveys are required, throughout the restored site.

Types of restoration

Each designer can contextualize the environmental restoration by choosing the most appropriate actions, but that notwithstanding rough guidelines of possible interventions to achieve recovery of plant cover are required.

Three types or classes context have been identified:

A. escarpments and slopes with a gradient over 35%; wooded areas; meadows and pastures - linear interventions;
B. meadows and pastures - large areas;
C. wetlands.

Below actions functional to restoration are described.

TYPE OF ACTION	A			B		C
CONTEXT	Escarp-ments and slopes with a gradient >35°	Wood-lands	Meadows and pastures			Wet-lands
			Linear interventions	Large surfaces		
ALTITUDE	All			Plain, hills and mountains	Sub-alpine and alpine	All
Topsoil removal and stocking of grass turf	●		●		●	●
Watering stored turf piles	●				●	●
Stocking of topsoil	●	●	●	●	●	
Watering piles of soil organic layers	●	●		●	●	
Topsoil addition				●	●	
Fertilization	●			●	●	
Harrowing				●	●	
Laying bio-mats	●	●				
Hydro-seeding	●	●	●			●
Mechanical seeding				●	●	
Rolling				●	●	
Distribution of grass or hay	●	●	●	●	●	●

TYPE A

escarpments and slopes with a gradient over 35%, wooded areas, linear interventions in meadows and pastures

This type of intervention or action includes works carried out at any altitude where mechanical seeding is impossible:

- on steep terrain with gradients of more than 35% - slopes, road embankments, excavations and surface arrangement of ski slopes;
- excavations to lay down sub-utilities such as pipelines, mains, power lines along very steep slopes with grassy turf or tree formations;
- linear interventions in meadows and pastures.

On steep terrain, the gradient is the critical factor determining a successful outcome of environmental recovery, since surface runoff leads to greater soil erosion and seed removal, compromising the establishment of plant cover.

TYPE B

meadows and pastures - large area interventions

When large areas of grass or pasture-land must be restored, agronomic work suited to recovery of the soil component is required.

TYPE C

wetlands

In the restoration of wet grasslands at any altitude, the availability of water determines success.

As a result, one should check and possibly restore the water network to what it was before the disturbance factor and check the level of the water horizon before proceeding with seeding.

Vehicle traffic should be reduced to a minimum to avoid excessive soil compaction.

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Methods

Topsoil removal and stocking of grass turf

In the presence of turf, the latter must be removed before excavation, setting the turf clods aside.

In linear interventions, where it is advisable to proceed by finished sections, clods must be set aside on the edge of the excavation, taking care not to cover them with the subsequently extracted materials.

In the case of large areas of work, turf must be piled up in heaps, possibly in a shaded area, and, when the work is finished, it must be repositioned on the filling material and compacted.

If work is carried out in a woody area, with excavations also involving the removal of the tree cover, the repositioning of the clods will have little chance of success, because the herbaceous sciaphilous species will suffer following sudden exposure.

In the subalpine and alpine belts, where there are greater difficulties in recovering the turf cover, sod removal must be carried out before excavation, possibly accumulating the turf in the shade. When the work is finished, turf must be repositioned and compacted before seeding.

Watering stored turf piles

The turf piles should be watered periodically until they are reused, depending on weather conditions, to prevent them from drying out. This is even more so in wetlands, where the turf heaps should be stored in an area of great water availability if possible.

This is not necessary if work is quickly carried out in finished sections, as happens in linear interventions.

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Stocking of topsoil
In earth-moving, care must be taken to preserve the topsoil, rich in organic matter and nutrients, which must be deposited in temporary piles no higher than 1.5-2.5 m, to be reused in the subsequent phases of remodelling[15].
Soil organic layers should be stored separately from the soil with higher mineral component, which is found in the deeper layers[16].

Watering piles of soil organic layers
Soil piles should be periodically watered to limit degradation.

Topsoil addition
In situations where the soil is chemically and physically severely degraded or completely absent - for example in quarry areas or on construction sites subject to repeated vehicle passage - it is not possible to store and reuse the organic soil layer. In these cases, it is necessary to find and store soil from elsewhere to rebuild a topsoil suitable for successful grassing.
The number of layers, their texture and thickness depend on the soil characteristics prior to restoration, environmental conditions, permeability and fertility requirements that the planner intends to restore. As a general rule, when there is absolutely no soil, a first layer of material has to be put in place with a larger texture and, subsequently, finer soil richer in organic matter. In Italy, topsoil addition is regulated by Presidential Decree 120/2017[17].

Fertilization
In productive grasslands, to increase soil fertility, it is advisable to spread mature manure (35 t/ha) using the appropriate

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machinery (manure spreaders). If mature manure is not available, quality compost can be an effective substitute[18].

Harrowing

In order to bury manure in grasslands and to reduce soil compaction generally due to repeated vehicle passing and materials, harrowing must be carried out at a depth of about 20 cm.

Laying bio-mats

In order to limit surface erosion and facilitate the turf settlement, putting an anti-erosion coating in place is recommended[19]. Completely biodegradable natural material is the preferable choice among the many products on the market: bio-textiles in jute or coconut, with degradation time from 1 to 5 years, able to adapt and adhere to the profile of the soil. In addition to mechanically limiting runoff, soil and seed loss, bio-textiles allow a higher degree of soil moisture retention and are therefore particularly suited to south facing slopes.

In order not to create voids and soil accumulation, the mat must be carefully staked with no less than 1 picket/m^2, overlapping at least 10 cm of one sheet to the next.

Hydro-seeding

Hydro-seeding is a technique that can be usefully employed to sow preservation mixtures even on relatively flat land, but especially on steep slopes.

In order to limit the wash-out of seed and accelerate its germination, on escarpments and steep slopes, sowing

must be carried out a heavy hydro-seeding, using a mixture of tackifiers, mulching, silt and humus. Spreading in two passages, on previously watered soil, 2 l/m^2 of a mixture containing 10 g/m^2 of hay-flower in aqueous solution. The mixture shall consist of:

- balanced organo-mineral fertilizer and microelements, at least 150 g/m^2;
- high viscosity colloid of natural origin, at least 15 g/m^2;
- mulch consisting of 100% wood fibre at about a 200 g/m^2 ratio.

At the end of soil repositioning and remodelling, seeding must be carried out promptly, trying to make these steps coincide in the optimal periods according to the bioclimatic characteristics of the site.

Mechanical seeding
Seeding should be performed using doses of 100 kg/ha of hay-flower. Seeding machines must be suited to the distribution of a fairly coarse material, such as the seed mixture collected by meadow brushing.
Seeds must be carefully mixed before being poured into the hopper, to avoid uneven distribution on the ground.
If possible, seeding should be scheduled for early spring or late autumn so as not to expose germinating seeds and seedlings to water stress in the early stages of growth. In practice, however, the time will be determined by the progress of the work. In case of summer seeding, it is advisable to increase the hay-flower up to 120 kg/ha to compensate for the risks of failure and to counteract the more aggressive summer weeds.

Rolling
When working on grasslands, rolling must be carried out immediately after mechanical seeding to help the seed to adhere to the soil and promote germination.

Distribution of seed-rich grass or hay
In many situations, the use of fresh grass or seed-rich hay can be a very good alternative to preservation mixtures. No specific mechanisation is required for collecting, as the same machines already available in fodder and livestock farms are used. The harvested material contains most of the seeds present in the meadow and, once spread, protects them with an organic mulch, creating favourable conditions for germination and turf settlement. The amount of fresh grass can vary, depending on the risk of erosion and drying of the mass, from 0.5 to 2 kg/m^2, corresponding approximately to 3 to 10 cm in thickness. If hay is used, a uniform 3-5 cm layer is recommended[20].

Costing: the use of preservation mixtures

In Italy, in the event of public works, the cost of work must be calculated during the design phase using the *Price List for Supplies and Works* formally adopted by each Region. For supplies and work not included in the Region's price list, costing is required, or, for supplies, reference has to be made to verifiable market prices.
In Italy, only some Regions have included in their price lists the items relating to the supply of preservation material and to the different types of revegetation with the same material.
In the framework of the Alp'Grain project, the production costs of preservation mixtures were evaluated in relation to different types of firms, that is harvesting farm, processing company conditioning and marketing mixtures, farmers' organisations. However, at the moment, the Aosta Valley regional price

list does not include costs of preservation mixtures or their use.
As a result, we analysed existing costs to define the reference prices and enable those designing the project to comply with the obligation of using local native plant materials in protected areas with defined costs and indications for the whole regional territory. Should the regional price list be updated, hopefully it will be able to include the supply and use of preservation materials in the list of entries for public works.
The same values of productivity, processing time and reference prices used for the definition of compensation to producers were applied for these calculations. Similarly, in analysing prices for supplies of materials, the distinction defined for the calculation of the compensation to farmers between grasslands was maintained for fresh grass cutting, while it was simplified for seed brushing, reducing it to two types (irrigated meadows at all altitudes and dry meadows/pastures at all altitudes) as the difference in the amount obtained from the analyses was minimal.

The detailed price analysis is available on the website of the *Institut Agricole Régional*.

In France, no similar parameter analysis has been developed for the evaluation of the cost of compensation and actions, as the amounts are directly agreed, with the owners and tenants on an *ad hoc* basis.

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CONCLUSIONS AND OUTLOOK

RestHAlp's contribution

This handbook is the result of the knowledge built up throughout the project, including the pilot restoration of degraded natural sites, planned and tested technical innovations and networking among players. Our main aim was to supply the *Natura 2000* site managers, planners, enterprises and farmers tools to plan, implement and monitor ecological recovery in degraded sites.

Pilot ecological restoration projects were carried out on both sides of the Alps. In the Aosta Valley, in the Gran Paradiso National Park, RestHAlp was involved in the restoration of two areas adjacent to the *Water and Biodiversity* Visitor Centre in Rovenaud, Valsavarenche. Seeds collected in permanent meadows were used to re-grass a hay meadows, while seeds for restoring a wet grassland were harvested in the Val Ferret SPA *(Special Protection Area)*.

The Les Îles di Saint-Marcel Wetlands Nature Reserve/SPA/SAC suffered the invasion of Bohemian knotweed *(Reynoutria bohemica)*. Work was carried out for years to eliminate or contain the invasive alien species and to restore semi-natural dry grasslands using the xeric grasslands west of the site as a source.

The Nature Reserve/SAC "Zona umida di Morgex", one of the few remaining examples of the Dora Baltea river alluvial plains together with Les Îles di Saint-Marcel Wetlands, had been partially affected by works to replace a sewer pipe. The consequent restoration included land reclamation and reconstitution of the permanent meadows using seed rich mature grass harvested close by.

Areas with the same habitat «Mountain hay meadows» were also restored in the Val Ferret SPA (Courmayeur). Over time, the underuse of the grasslands at the entrance to Val Ferret had caused the growth of invasive shrubs and the impoverishment of the floristic composition, threatening the very existence of the habitat. Soil was prepared and sowed using seed mixtures from the same SPA and good farming practices introduced to maintain the habitat.

In the Pont d'Aël (Aymavilles) SAC, small landslide scarps and escarpments uphill from the path had to be grassed following work to restore old dry stone walls. The xeric habitat was restored using a preservation mixture collected with a brushing machine in the Les Îles di Saint-Marcel SAC/SPA/Nature Reserve.

RestHAlp also operated in many Savoy sites: in the "Marais des Lagneux" (Yenne), barren brome *(Anisantha sterilis)* that had invaded the entire wetland was removed. Following extirpation the area was re-colonised mainly by the common reed *(Phragmites australis)* and the hedge bindweed *(Calystegia sepium)*.

In the St. Pierre d'Albigny vineyards, revegetation under cultivated rows was experimented using preservation mixtures from xeric meadows.

In the Marais de la Bialle (Aiton) and the Marais de Bondeloge (Saint Jeoire Prieuré), over 70% of the wetlands had been invaded by the giant goldenrod

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(Solidago gigantea). To restore the original vegetation, the soil was lightly tilled and preservation seed mixtures collected from other wetlands of the Natura 2000 network were sown.

Reversing habitat degradation, due to alien species invasion, and following restoration have been the focus of other two projects at the Natura 2000 "Plaine des Hurtières" site, invaded by Bohemian knotweed, and by giant goldenrod in Val Coisin.

Furthermore, RestHAlp contributed to the important ecological renovation of the Chautagne wetland to the North of the Bourget Lake by making equipment available for the harvesting and threshing of local seeds and by sharing experience in selecting the best suited revegetation techniques for the site.

Some of the above restoration projects were an opportunity to organise events and demonstrations for the relevant professionals, managers of nature reserves and for the communities. Seed collection directly from natural grasslands was presented in events on the two sides of the Alps, in Sainte-Hélène-du-Lac and Courmayeur. The latter was organised at the foot of the Mont Blanc at the height of the tourist season: it became an interesting opportunity to inform and raise awareness both among tourists and among local professionals and workers. Bohemian knotweed extirpation and the restoration of local vegetation were illustrated at the Plaine des Hurtières site, an event echoed by the media too.

One of the project's added values was the use of experimental DNA testing based on Sanger sequencing, the Next Generation Sequencing (NGS) and real-time PCR. The tests were used to identify the floristic composition of source areas, to asses soil total and microbial biodiversity before restoration and to trace the relevant plant species for the preservation and restoration of the habitat.

As well as pilot experiences, an innovative prototype of a pulled brushing machine for the collection of wild seeds was designed, built and patented. The machine has a simplified system for unloading the collected material, in order to reduce working time, allow faster and more timely collection and facilitate handling of the machine and of the collected seeds. A drying system was also assembled to be used in conjunction with the harvesting machine, specifically designed for the conditioning of wild seeds.

Outlook

This Handbook outlines a *modus operandi* for all those involved in the ecological restoration chain; it also illustrates the various actions defining costs of implementation. The aim is to develop a useful tool for disseminating restoration knowledge and methods to all the players directly involved in the management of the territory, within an adequately structured supply chain for the collection and use of preservation mixtures.

In spite of the interest received, the use of wild seeds in the conservation or restoration of natural habitats is still not easily implemented because of the difficulties in establishing the supply chain, making it sustainable and monitoring it.

Since habitat restorations in mountain areas require a short supply chain, with the collection site being close to the one to revegetate, it would be necessary to establish a coordination action at regional or departmental level between demand and supply of local seeds. The demand, overseen by the Nature Reserve managing bodies; should be included in a multi-year planning of the restoration to be implemented; the offer should come from farms prepared to invest and to specialise in the collection of preservation mixtures.

at regional or departmental level, it would be necessary to establish a coordination action between demand and supply of local seeds; the request, from the managing bodies of the protected areas, should be included in a multi-year planning of the restoration interventions to be implemented; the offer should come from farms willing to invest and specialize in the collection of preservation mixtures.

The entrepreneurship of farms can be supported by the Rural Development Programme for the purchase of specialised machinery and equipment for harvesting and drying hayseed and for the preparation of warehouses for conditioning and storage of preservation mixtures.

It is essential to promote the preservation seeds supply chain with specific training courses, at regional or departmental level, on the techniques of collection, conservation and use of the seed mixtures. Farmers interested in differentiating their activity could attend. At the same time, training should also involve the subjects in charge of planning the works, designing them and carrying them out, and those who have to carry out the surveillance of the territory and control the execution of the interventions.

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PILOT PROJECTS: EXAMPLES

Les Îles di Saint-Marcel wetlands

Technical information

SITE	
Region	Vallée d'Aoste
Natura 2000 site	IT1205070 - Zona Umida di Les Îles di Saint Marcel
Municipality – hamlet	Saint-Marcel – Les Îles
Elevation and topography	530 m asl – Flat valley floor (Dora Baltea River alluvial zone with re-naturalised eutrophic artificial lakes)
Identified issue	Invasion of ruderal species and Bohemian knotweed
Habitat to be restored	6210 «Semi-natural dry grasslands and scrubland facies on calcareous substrates *(Festuco-Brometalia)*»
Managed by	Regione Autonoma Valle d'Aosta
RESTORATION	
Aim	Restoring the dry grassland area
Method of restoration	Sowing with seed rich grass following the extirpation of invasive plants and the preparation of the soil
Surface	2,000 m^2
Work performed	• extirpation of ruderal species and Bohemian knotweed, collection, transport and burning • Mechanical removal and subsequent repositioning of the stone curb • Mechanical tillage • Manual levelling and finishing • Seed rich grass cutting • Gathering and transporting grass • Grass distribution • Rolling • Rescue irrigation and manual extirpation of the new Bohemian knotweed nuclei
Contracting Authority	Regione Autonoma Valle d'Aosta
HARVESTING	
Collection site	In site IT1205070, on dry grassland West of the area to restore with the same 6210 habitat.

Harvested area	6800 m^2
Harvested material	Mowing machine; cut grass was then hand loaded onto a truck
Harvesting date	July 30th, 2019
Service provider	Private company, contracted by the Regione Autonoma Valle d'Aosta
Ownership of the collection site	Regione Autonoma Valle d'Aosta
SOWING	
Sowing date	July 30th, 2019
Sowing method	Hand sowing of seed rich grass
Amount of plant material used	Circa 1.2 t of seed rich grass, on average corresponding to 600 g/m^2
Service provider	Private company, contracted by the Regione Autonoma Valle d'Aosta

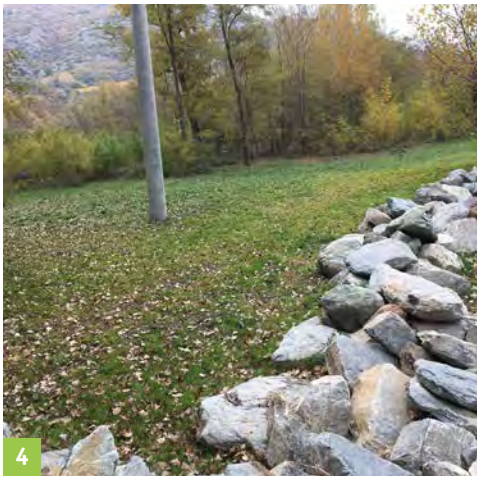
RESTORATION COSTS (TAX INCLUDED)	
Elimination of knotweed and of unwanted plants	5,400 €
Mechanical removal and subsequent repositioning of the stone curb	4,700 €
Soil preparation	5,500 €
Mowing, gathering and transporting seed rich grass	3,400 €
Distributing the mowed grass and rolling	1,400 €
Rescue irrigation and manual extirpation of the new Bohemian knotweed nuclei for the first 12 months following removal	1,100 €
Hand extirpation of isolated plants in subsequent years	2,000 €
Hand cutting limitation of dense nuclei in subsequent years	5,000 €
TOTAL	**28,500 €**

Implementation

Although several attempts to eliminate Bohemian knotweed *(Reynoutria bohemica)* in the area had been made in past years, new colonisation was observed close to the wooded area with re-growth being particularly strong in the loose stone curb marking the cycle path. Extirpation was performed mechanically on the central surface and manually close to the trees. The loose stone had to be removed to extirpate *Reynoutria* plants. The stones were repositioned after the extirpation of the invasive plants.

Results and general assessment

Ten months later, the result was appreciable: the sward has settled as expected and the number of specimens of Bohemian knotweed has been significantly reduced. Observations should continue throughout the growing season and, if necessary, manual removal of re-growth should be performed in a timely manner.



1 Area invaded by ruderal species and Bohemian knotweed.
2 Area after mechanical tillage.
3 Surface to restore, immediately after the distribution of the seed rich grass.
4 Area recovered, in autumn 2020.

©RAVA

Rovenaud - Valsavarenche wetlands

Technical information

SITE	
Region	Aosta Valley
Natura 2000 site	IT1201000 – Parco Nazionale Gran Paradiso
Municipality - hamlet	Valsavarenche - Rovenaud
Elevation and topography	1 459 m asl – Eastern exposure of flat valley floor
Identified issue	• Floristic degradation of wet grasslands due to lack of water supply following the occlusion of the irrigation network. • Spread of shrubs and non-characteristic herbaceous species. • Before the construction of the Centre, the area underwent incorrect pastoral management (e.g. livestock stationing in the less humid sections).
Habitat to be restored	6410 "*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae)*", in wetlands; 6520 "Mountain hay meadows", close to wetlands.
Managed by	Parco Nazionale Gran Paradiso
RESTORATION	
Aim	To restore wet meadows
Method of restoration	Sowing with seed preservation mixture, following the extirpation of unwanted species, soil preparation and the reconstruction of the irrigation network.
Surface	2,100 m^2
Work performed	• Manual and mechanical bush cutting; • Manual extirpation of unwanted herbaceous species; • Hand hoeing; • Mechanical soil shaping; • Manual stone removal; • Manual soil finishing; • Sowing with preservation mixtures; • Restoration of irrigation network.
Contracting Authority	Parco Nazionale Gran Paradiso

HARVESTING		
Collection sites	In SPA IT1204030 – Val Ferret, in hamlet Praz Sec du Milieu (1632 m asl), in 6410 "*Molinia* meadows on calcareous, peaty or clayey-silt laden soils *(Molinion caeruleae)*"..	In the PNGP (IT1201000), hamlet Bien near Valsavarenche, in habitat 6520 "Mountain hay meadows".
Managed by	Regione Autonoma Valle d'Aosta	Parco Nazionale Gran Paradiso
Harvested areas	1,300 m^2	1,600 m^2
Harvested material	Seed mixture collected with brushing machine and cleaned manually.	
Harvesting date	August 6th, 2019	August 14th, 2019
Service provider	Institut Agricole Régional	A farm contracted by the PNGP
Ownership of the collection site	Privately owned	
SOWING		
Sowing date	September 18th, 2019	
Sowing method	Broadcast seeding of preservation mixtures	
Service provider	A private company contracted by PNGP	

RESTORATION COSTS (TAX INCLUDED)	
Wet meadow restoration	15,200 €
Irrigation network restoration	6,600 €
TOTAL	**21,800 €**

Implementation

Near the *Water and Biodiversity* Visitor Centre of the Parco Nazionale Gran Paradiso in Rovenaud - Valsavarenche, there was a regressing wet meadow (with *Carex spp.*, *Deschampsia cespitosa* etc.) due to the deterioration of the irrigation network, which does not allow a constant flow of water, and to the invasion of non-characteristic herbaceous vegetation *(Rumex obtusifolius, Heracleum sphondylium, Anthriscus sylvestris)* and hygrophilous shrubs and bushes (*Salix spp.* etc.).
The operation consisted in the restoration of the wet grassland by the elimination of herbaceous and infesting shrubs; the reconstruction of the irrigation network and canal excavation; the installation of sluice gates to maintain constant water availability. After the removal of stones and soil levelling, the seed mixture from the Val Ferret SPA (habitat 6410 «*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils» with mosaic habitat 7230, «Alkaline fens») was sown in the wettest area, while in the surrounding area a seed mixture collected in the same municipality, in a Mountain hay meadow (habitat 6520), was sown.

Results and general assessment

Work was carried out in autumn 2019. During the inspection carried out at the end of May 2020, a good germination of the local seeds sown in the restored areas was observed.
Subsequently, the management plan for the area provides:

- mowing and clearing to contain the development of annual herbaceous species;
- subsequent annual mowing, using light means, so as not to compact the soil;
- maintenance of the irrigation network to ensure constant water availability to plants;
- in autumn 2020, in the event of missing or poorly present characteristic species of the habitat, they will be integrated by sowing the seed gathered by hand at the donor site.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1 The area before the restoration work, September 2018. *©IAR*
2 Area after clearing and land shaping, September 2019. *©IAR*
3 Seed harvesting in Val Ferret. *©E. Pittana*
4 Good vegetation cover by resown local species, May 2020. *©IAR*

Escarpments in Pont d'Aël - Aymavilles

Technical information

SITE	
Region	Aosta Valley
Natura 2000 site	IT1205030 - Pont d'Aël
Municipality - hamlet	Aymavilles – Pont d'Aël
Elevation and topography	900 m asl - Xeric slope, East aspect
Identified issue	Need to revegetate small landslide scarps and escarpments above the path, following the restoration of old dry stone walls.
Habitat to be restored	6210 "Semi-natural dry grasslands and scrubland facies on calcareous substrates *(Festuco-Brometalia)*"
Managed by	Regione Autonoma Valle d'Aosta
RESTORATION	
Aim	Reconstitution of the sward to limit surface erosion and complete slope consolidation work
Method of restoration	Revegetation with a preservation mixture
Surface	7 landslide scarps totalling 200 m^2
Work performed	• Levelling escarpments • Jute bio-netting • Hand seeding
Contracting Authority	Regione Autonoma Valle d'Aosta
HARVESTING	
Collection site	IT1205070 Zona Umida di Les Îles di Saint Marcel, habitat 6210 "Semi-natural dry grasslands and scrubland facies on calcareous substrates *(Festuco-Brometalia)*"
Harvested area	6,800 m^2
Harvested material	Seed mixture collected with brushing machine and cleaned manually.
Harvesting date	July 13th, 2018
Service provider	Institut Agricole Régional
Ownership of the collection site	Regione Autonoma Valle d'Aosta

SOWING	
Sowing period	July 2019
Sowing method	Broadcast seeding of preservation mixture
Density	About 50 g/m^2 of mixture
Amount of plant material used	10 kg
Service provider	Private company

Implementation

Revegetation was carried out to complete the consolidation of path 2A, coinciding with the Cammino Balteo (*Balteo Path, Bassa Via* n°3), in the stretch between the aqueduct bridge and the tunnel.
The slope crossed by the path has markedly xeric features, which is why sowing was carried out in October. Given the impossibility of accessing by mechanical means, sowing was broadcast on bare ground or soil previously covered with jute net by the company that carried out the restoration of the dry stone walls.

Results and general assessment

Given the xericity of the site, which does not favour seed germination and sward establishment, results observed in May 2020 were satisfactory. In the steepest scarps, despite the bio-net, the runoff of the seeds was more marked and the establishment was not even, leaving alternating bare and grassy areas.


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1 Escarpment covered with jute geotextile, August 2018
2 Broadcast seeding, October 2018.
3 Detail of the sown mixture.
4 Considerable but uneven revegetation, May 2020.

©E. Pittana

Marais des Lagneux

Technical information

SITE	
Department	Savoy
Natura 2000 site	FR8201770 - Réseau de zones humides, pelouses, landes et falaises de l'avant-pays savoyard
Municipality	Yenne
Elevation and topography	230 m asl – Alkaline lowland wetland
Identified issue	Eutrophic area completely colonised by barren brome (*Anisantha sterilis*)
Habitat to be restored	Dry and flooded *Phragmites* beds (Corine codes 53.111 and 53.112)
Managed by	Conservatoire d'Espaces Naturels de Savoie
RESTORATION	
Aim	Reconversion of the surface to *Phragmites* beds
Method of restoration	Hand sowing
Surface	1,600 m^2
Work performed	• Plant grinding & soil tillage (15 cm)
Contracting Authority	Conservatoire d'Espaces Naturels de Savoie
HARVESTING	
Collection site	Location: Marais de Terre-Nue (Viviers-du-Lac) Natura 2000 site: Special Protection Area FR8212004 Code Habitat: (53.111; 53.21; 37.1 and 37.2); Natura 2000 code (72.30)
Harvested area	0,2 ha
Harvesting machinery	Pull Type Seed Harvester by Prairie Habitats
Harvesting date	July 4th, 2018
Service provider	Entente interdépartementale pour la Démoustication Rhône Alpes
Ownership of the collection site	Conservatoire du Littoral
SOWING	
Sowing date	May 6th, 2019
Sowing method	Hand sowing
Density	2,5 g/m^2
Amount of plant material used	4 kg of pure seeds
Service provider	Private company, contracted by the Conservatoire d'Espaces Naturels de Savoie

RESTORATION COSTS (TAX INCLUDED)	
Soil preparation	600 €
Harvesting	580 €
Sowing	700 €
TOTAL	**1,880 €**

Implementation

Due to high water levels in spring, seeding was delayed, increasing the risk of a difficult establishment of the wet grassland due to competition with the other species.

Results and general assessment

Rotavator seedbed preparation was carried out in May 2019 and removed the barren brome that occupied the entire station. Barren brome did not grow back following this mechanical intervention, probably because it was performed during a phase of the species cycle blocking the germination of the soil seed bank.
The land was then re-colonized mainly by two species: the common reed *(Phragmites australis)* and hedge bindweed *(Calystegia sepium)*. These two species did not originate from the sown seeds, while few plants of blunt-flowered rush *(Juncus subnodulosus)*, perhaps originating from these seeds, were also observed.

1 Site overview, May 2019.
2 Barren brome destroyed by soil preparation (left) and flowering (right), May 2019.
3 Winter colonization of annual species (left) and barren brome in vegetative stage, reappeared after mowing (right), February 2020.

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Vineyards in the municipality of Saint Pierre d'Albigny

Technical information

SITE	
Department	Savoy
Municipality	Saint Pierre d'Albigny
Elevation and topography	380 m asl - Hilly vineyard
Type of environment	Vineyard established in a former permanent mesoxerophilic meadow
Identified issue	The meadow was tilled before planting the vines, with consequent sowing on the new substrate
Habitat to be restored	6210 "Semi-natural dry grasslands and scrubland facies on calcareous substrates *(Festuco-Brometalia)*"
Managed by	Conservatoire d'Espaces Naturels de Savoie
RESTORATION	
Aim	Grassing vineyard inter-row by sowing seeds collected from a nearby meadow
Method of restoration	Sowing wild seeds harvested from dry meadows
Surface covered	330 m^2
Work performed	• Ploughing
Contracting Authority	Conservatoire d'Espaces Naturels de Savoie
HARVESTING	
Collection site	Seeds were harvested on the Natura 2000 site in the Marches Municipality, in the SAC FR8201773 «Réseau de zones humides dans la Combe de Savoie et la moyenne vallée de l'Isère», on the following habitats: 34.324 and 37.311 (Natura 2000: 6210 and 6410).
Harvested area	0.8 ha
Harvesting machinery	Pull Type Seed Harvester by Prairie Habitats
Harvesting date	August 4th, 2017
Service provider	Entente interdépartementale pour la Démoustication Rhône Alpes
Ownership of the collection site	Private owner
SOWING	
Sowing date	April 26th, 2018
Sowing method	Hand sowing

Density	30 g/m²
Amount of plant material used	10 kg
Service provider	Conservatoire d'Espaces Naturels de Savoie

RESTORATION COSTS (TAX INCLUDED)	
Harvesting	200 €
Sowing	120 €
TOTAL	**320 €**

Implementation

If vines are planted after ploughing, plants take more easily. Nevertheless, it is more difficult to quickly re-establish a species-rich grassland. When establishing a vineyard, soil preparation should leave the grass-cover in place in the inter-row spaces and only work the row for planting the bench grafts.

Results and general assessment

The experimental nature of this action, which also suffers from two limitation, has to be borne in mind:

- a non-xerophilic, non-oligotrophic and freshly tilled substrate, highly exposed to competition by weeds and the soil seed bank; and
- a seed source that does not comply with these conditions: an oligotrophic meadow on marl, dry alluvial grassland rich in annuals.

One year after sowing, the site's floristic analysis shows that:

- the reseeded and overseeded areas have greater vegetation cover and specific richness than the comparison areas, not sown;
- the reseeded areas have a lower vegetation cover, but greater specific richness and diversity than the overseeded areas;
- the reseeded areas have a slightly higher proportion of target species than the overseeded areas.


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1 Inter-rows of the vineyard in the control plot, not reseeded.
2 Reseeded inter-rows in the vineyard.
3 Floristic surveys for monitoring revegetation in the vineyard inter-rows.
4 Frame used for floristic surveys (control plot, not reseeded).

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Marais de la Bialle

Technical information

SITE	
Department	Savoy
Natura 2000 site	FR8201773 - Réseau de zones humides dans la Combe de Savoie et la moyenne Vallée de l'Isère
Municipality	Aiton
Elevation and topography	300 m asl - Lowland marshes
Type of environment	Lowland eutrophic megaphorb with goldenrod and sedge meadows
Identified Issue	Presence of giant goldenrod *(Solidago gigantea)* making up 70% of the flora
Habitat to be restored	6410 "*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae)*"
Managed by	Conservatoire d'Espaces Naturels de Savoie
RESTORATION	
Aim	To restore a diverse wetland hay meadow
Method of restoration	Sowing of local seeds after light tillage of the soil
Surface covered	5,000 m^2
Work performed	· Tillage
Contracting Authority	Conservatoire d'Espaces Naturels de Savoie
HARVESTING	
Collection site	Seeds were gathered at the Natura 2000 site Commune des Mollettes, in the SAC FR8201773 - «Réseau de zones humides dans la Combe de Savoie et la moyenne vallée de l'Isère» (Les Mollettes), in the Zone Naturelle d'Intérêt Ecologique, Faunistique et Floristique (Nature Zone of Ecological, Fauna and Flora Interest) 820031499 – «Marais du Coisetan et du Lac Sainte Hélène», Natura 2000 Habitat Code (6410) Corine Code (37.31)
Harvested area	16 ha
Harvesting machinery	Pull Type Seed Harvester by Prairie Habitats
Harvesting period	Mid-July 2017 and 2018
Service provider	Entente interdépartementale pour la Démoustication Rhône Alpes
Ownership of the collection site	Conservatoire d'Espaces Naturels de Savoie

SOWING	
Sowing date	May 28th, 2019
Sowing method	Hand sowing
Density	2,5 g/m²
Amount of plant material used	12.5 kg of pure seed
Service provider	Private company, on behalf of Conservatoire d'Espaces Naturels de Savoie

RESTORATION COSTS (TAX INCLUDED)	
Soil preparation	1,900 €
Harvesting	2,900 €
Sowing	2,100 €
TOTAL	**6,900 €**

Implementation

Due to high water levels in spring, seeding was delayed, increasing the risk of a difficult establishment of the wet grassland due to competition with the other species.

Results and general assessment

Results for year 1 were relatively mixed. Observation over 2 to 3 growing seasons would be more appropriate to assess the ecological value of the grassland.
Seeding density (25 kg/ha) will also have to be assessed as it is relatively low compared to agricultural grassland seeding.


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1 The area before the restoration work, April 2019.
2 On the left, the plot after tillage and before sowing, on the right, without tillage, June 2019.
3 Site after sowing, June 2019.
4 Evolution of the vegetation, August 2019.

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Marais de Bondeloge

Technical information

SITE	
Department	Savoy
Natura 2000 site	None. National code: FR1501984
Municipalities	Saint Jeoire Prieuré ; Myans ; Chignin
Elevation and topography	295 m to 297 m asl - Lowland wetlands
Type of environment	Dry reed bed with goldenrod
Identified issue	Presence of giant goldenrod *(Solidago gigantea)* making up 70% of the flora
Habitat to be restored	6410 "Molinia meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae)*"
Managed by	Conservatoire d'Espaces Naturels de Savoie
RESTORATION	
Aim	To restore a species-rich wet meadow
Method of restoration	Sowing of local seeds after light tillage of the soil
Surface covered	5,000 m^2
Work performed	• Tillage
Contracting Authority	Conservatoire d'Espaces Naturels de Savoie
HARVESTING	
Collection site	Seeds were gathered at «Cul du Bois» (Chindrieux), in the protected wetland under the Ramsar Convention FR7200021 - Lac du Bourget - Marais de Chautagne, Natura 2000 Site: SPA FR8212004, Code Habitat: (53.21; 37.1 and 37.2)
Harvested area	0.6 ha
Harvesting machinery	Pull Type Seed Harvester by Prairie Habitats
Harvesting dates	July 6th, 2017 and June 26th, 2018
Service provider	Entente interdépartementale pour la Démoustication Rhône Alpes
Ownership of the collection site	Conservatoire d'Espaces Naturels de Savoie
SOWING	
Sowing date	May 27th, 2019
Sowing method	Hand sowing
Density	2.5 g/m^2

Amount of plant material used	12.5 kg of pure seed
Service provider	Private company, on behalf of the Conservatoire d'Espaces Naturels de Savoie

RESTORATION COSTS [TAX INCLUDED]	
Soil preparation	1,900 €
Harvesting	250 €
Sowing	2,100 €
TOTAL	**4,250 €**

Implementation

Due to high water levels in spring, seeding was delayed, increasing the risk of a difficult establishment of the wet grassland due to competition with the other species.

Results and general assessment

Results for year 1 were relatively mixed. Observation over 2 to 3 growing seasons would be more appropriate to assess the ecological value of the grassland.
Seeding density (25 kg/ha) will also have to be assessed as it is relatively low compared to agricultural grassland seeding.

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1 Area to be restored, soil preparation with light harrowing before sowing, May 2019.
2 Plot tilled (right) and control plot not tilled (left), May 2019.
3 Plot after germination, July 2019..
4 Restored plot (right) and unrestored plot (left), February 2020.

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ENDNOTES

1 - Di Noi, 2005.
2 - Society for Ecological Restoration International Science & Policy Working Group, 2004.
3 - Bischoff *et al.*, 2010 ; Vander Mijnsbrugge *et al.*, 2010.
4 - Direction régionale de l'environnement, de l'aménagement et du logement (Regional authority of environment, planning and housing).
5 - Azienda Nazionale Autonoma delle Strade (Road Agency).
6 - EU Regulation 1143/2014.
7 - Bassignana *et al.*, 2015.
8 - Dupré La Tour *et al.*, 2018.
9 - Web Map Service, constantly updated data bank.
10 - RAVA, 2009.
11 - Bassignana *et al.*, 2015.
12 - RAVA, 2017.
13 - McDonald *et al.*, 2016.
14 - Jaunatre *et al.*, 2017.
15 - Curtaz *et al.*, 2012.
16 - Meloni *et al.*, 2019.
17 - Regulation containing the simplified discipline of the management of excavated earth and rocks.
18 - Bassignana *et al.*, 2012.
19 - APAT, 2002.
20 - Scotton *et al.*, 2012.

GLOSSARY OF ACRONYMS

ANAS
Azienda Nazionale Autonoma delle Strade

CBNA
Conservatoire Botanique National Alpin

CRA-SCS
Centro di sperimentazione e certificazione delle sementi (Seed testing and certification center)

CTPS
Comité Technique Permanent de la Séléction des plantes cultivées (Permanent technical committee for the selection of cultivated plants)

DREAL
Direction régionale de l'environnement, de l'aménagement et du logement (Regional authority of environment, planning and housing)

EU
European Union

FADN
Farm Accountancy Data Network

GIS
Geographic information system

IAS
Invasive alien species

PNGP
Parco Nazionale Gran Paradiso

PNMA
Parco Naturale Mont Avic

RAVA
Regione Autonoma Valle d'Aosta

RPG
Registre Parcellaire Graphique

SAC
Special Area of Conservation

SCI
Site of Community Importance

SPA
Special Protection Area

REFERENCES

APAT, 2002. Atlante delle opere di sistemazione dei versante, secondo aggiornamento. Manuali e Linee guida, n. 10, 125 p.

Bassignana M., Curtaz A., Curtaz F., D'Amico M., Filippa G., Freppaz M., Icardi M., 2012. Manuale tecnico dei miglioramenti fondiari in zona montana. IAR, Aosta, 96 p.

Bassignana M., Madormo F., Spiegelberger T., 2015. Le sementi locali nel restauro ecologico in montagna. Produzione e uso di miscele per la preservazione, IAR Aosta, 96 p.

Bischoff A., Steinger T., Müller-Schärer H., 2010. The importance of plant provenance and genotypic diversity of seed material used for ecological restoration. Restoration ecology 18:338-348.

Curtaz F., Filippa G., Freppaz M., Stanchi S., Zanini E., Costantini E.A.C., 2012. Guida Pratica di Pedologia: Rilevamento di campagna, principi di conservazione e recupero dei suoli, IAR, Aosta, 155 p.

Di Noi A., 2005. Progettare il ripristino di un ecosistema. In: La rinaturalizzazione e il risanamento dell'ambiente per la conservazione della Biodiversità. APAT Rapporti 63/2005, 18-24.

Dupré La Tour A., Labatut J., Spiegelberger T., 2018. Pratiques de revégétalisation de milieux ouverts et perspectives pour la constitution d'une filière de semences d'origine locale en montagne alpine. Fourrages 236:269-274.

Jaunatre R., Gaucherand S., Rey F., Guerold F., Muller S., 2017. ASPIRE: un cadre méthodologique pour l'appréciation du succès des projets et de restauration écologiques: application à une opération de restauration d'une zone humide d'altitude. Science Eaux & Territoires n° 24. IRSTEA.

McDonald T., Gann G.D., Jonson J., Dixon K.W., 2016. International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington, D.C.

Meloni F., Lonati M., Martelletti S., Pintaldi E., Ravetto Enri S., Freppaz M., 2019. Manuale per il restauro ecologico di aree planiziali interessate da infrastrutture lineari, ISBN: 978-88-96046-02-9. Regione Piemonte.

Porteret J., Danancher D., Pache G., Pont B., Grossi J.-L., Dick R., 2017. Guide méthodologique d'utilisation des indicateurs pour le suivi des travaux de restauration - version 1. Conservatoire d'Espaces Naturels de la Savoie, Collectif RhoMéO. CPO thématique Trame bleue Espaces et Continuités, 25 p.

RAVA - Regione Autonoma Valle d'Aosta, Assessorato Agricoltura, 2009. Manuale contenente gli standards costruttivi e gli elementi di riferimento per il dimensionamento dei fabbricati rurali e degli annessi, 67 p.

RAVA - Regione Autonoma Valle d'Aosta, Assessorato Opere Pubbliche, 2017. Elenco prezzi per l'esecuzione di lavori pubblici di interesse regionale di cui all'art. 42 della legge regionale 20 giugno 1996, n. 12, e s.m.i (https://www.regione.vda.it/allegato.aspx?pk=41515).

Scotton M., Kirmer A., Krautzer B., 2012. Practical handbook for seed harvest and ecological restoration of species-rich grasslands. CLEUP, Padova, 116 p.

Society for Ecological Restoration International Science & Policy Working Group, 2004. The SER International Primer on Ecological Restoration. www.ser.org & Tucson: Society for Ecological Restoration International.

Vander Mijnsbrugge K, Bischoff A, Smith B., (2010). A question of origin: Where and how to collect seed for ecological restoration. Basic and Applied Ecology 11:300-311.

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