WWF / SER STANDARDS FOR THE CERTIFICATION OF ECOLOGICAL RESTORATION PROJECTS FOR FORESTS IN SPAIN

VERSION 4.0

WWF-SER Standards for the certification of ecological restoration projects for forests in Spain. Version 4.0

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WWF Spain is part of the WWF network, the largest independent international organisation dedicated to the defence of nature and the environment. Founded in 1961, we work in over 100 countries and are supported by nearly 5 million members worldwide. WWF's mission is to build a future where people live in harmony with nature, conserving and restoring biodiversity, reducing humanity's ecological footprint, and ensuring the sustainable use of resources to support current and future generations.

The Society for Ecological Restoration (SER) is a non-governmental organisation with members from over 100 countries worldwide. SER advances the science, practice, and policy of ecological restoration to sustain biodiversity, improve resilience in a changing climate, and re-establish an ecologically healthy relationship between nature and culture. SER is a dynamic global network, linking researchers, practitioners, land managers, community leaders and decision-makers to restore ecosystems and the human communities that depend on them. Via its members, publications, conferences, policy work, certification and standards programmes, and outreach, SER defines and delivers excellence in ecological restoration. Learn more about our work and get involved in the network: www.ser.org.

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INTRODUCTION

The WWF-SER Standards for the Certification of Forest Ecosystem Restoration Projects in Spain, Version 4.0 (WWF-SER Standards), comprise guidelines for the planning, implementation, ongoing management and monitoring of Spanish forest ecosystem restoration projects. They are aimed at professionals, technical staff and operators, planners, managers, regulators, legislative and political authorities, funding bodies, and companies involved in restoring degraded forest ecosystems seeking recognition of their work through certification. The standards also help to situate the ecological restoration of forest ecosystems in Spain in the European and global contexts, including its role in restoring biodiversity and enhancing ecosystem services in these times of uncertainty and rapid global change. They have been developed through a collaboration between WWF Spain, the Society for Ecological Restoration (SER) and other collaborators.

GLOBAL AND EUROPEAN CONTEXT: THE NEED FOR FOREST ECOSYSTEM RESTORATION

Ecological restoration is one of the main tools to mitigate and adapt to the effects of climate change, preserve and restore native biodiversity and reverse land degradation. It is key to achieving the *UN Sustainable Development Goals (SDGs) 2030,* especially Goal 14, *Underwater Life*, and Goal 15, *Terrestrial Ecosystem Life*, and contributes to the UN conventions to combat climate change (UNFCCC), biodiversity (CBD) and desertification (UNCCD). Restoration is essential to enhance the provision of ecosystem services that underpin the SDGs, the achievement of which largely depends on dependence and interlinkages between each of the SDGs. The United Nations designated 2021-2030 as the decade of ecosystem restoration to prevent, halt, and reverse ecosystem degradation worldwide (*United Nations Decade on Ecosystem Restoration Strategy 2021-2030, United Nations, 2020*). In addition, ecological restoration is a vital focus of the EU Biodiversity Strategy 2030, which proposes a Nature Restoration regulation for Europe with binding targets for Member States, and of the CBD's Kunming-Montreal Global Biodiversity Framework, which is supported by the EU and other European Parties to the CBD.

The success of these initiatives depends both on increasing the area restored and restoring the integrity of natural and semi-natural ecosystems. For this to happen, the quality of planning, implementation, ongoing management and monitoring and evaluation of restoration projects must be improved and expanded. It is crucial to ensure or certify the quality of restoration projects to invest more efficiently, generate the highest level of ecological recovery and deliver the greatest possible benefits. Forest ecosystems in Spain provide essential resources and regulate vital processes and functions, which make their conservation and restoration an excellent economic and social investment.

Geographical scope of the standards

The WWF-SER Standards are aimed at upscaling and outscaling to other regions and have been developed for natural or semi-natural environments in any of the three biogeographical regions, regardless of ownership.

In Spain, the concept of forest ecosystem ("monte" in Spanish) aligns more closely to the term *woodland*, as defined in Article 5 of Law 43/2003 on Forestry ("Ley de Montes", in Spanish). In this respect, the term is understood as "any land on which there is growth of tree, shrub, bush or herbaceous species, whether spontaneously or as a result of sowing or planting, which fulfil or may fulfil environmental, protective, productive, cultural, landscape or recreational functions". The following are also considered as woodland (within the definition of this law when regarding forest ecosystems in Spain): "barren land, rocky areas and sandy areas; abandoned agricultural land that meets the conditions and deadlines determined by the Spanish

Autonomous Communities - and provided they have acquired unequivocal signs of their woodland/forestry status; all land that, without meeting the characteristics described above, is assigned to be repopulated or converted to forestry use, according to the applicable regulations; and forest enclaves on agricultural land with the minimum surface area determined by the Spanish Autonomous Communities".

More generally, and from a standards perspective, a forest ecosystem (based on FAO, Spanish Forestry Plan and IUCN definitions) is a landscape area dominated by woody vegetation where ecological processes foster forest species and functions typical of forest land. They encompass trees and all vegetation types, animals and micro-organisms that inhabit wooded and scrub-shrub forest systems (both natural and semi-natural), all associated genetic diversity and the substrates and climate with which they interact.

THE NEED FOR STANDARDS SYSTEMS AND ASSOCIATED CERTIFICATION SCHEMES

Restoring degraded ecosystems is a complex task requiring time, resources, and expertise. In its broadest sense, encompassing the entire concept of ecosystem restoration, it includes a diverse set of actions, from regenerating agricultural soils to repairing damage to high-quality ecosystems within protected areas. Ecological restoration, however, specifically focuses on restoring natural and semi-natural ecosystems and aims to achieve the highest level of ecological recovery possible (Gann *et al.*, 2019). Ecological restoration contributes to recovering biodiversity and increasing ecosystem services, but many restoration projects and programmes could improve on the delivery of these outcomes.

The WWF-SER Standards recognise that the following practices can contribute to improving the outcomes of restoration projects:

- appropriate design
- good planning and implementation
- sufficient knowledge, skills, effort and resources
- understanding of the specific social context and risks
- appropriate stakeholder involvement
- appropriate monitoring and adaptive management

Applying standards, and ultimately certifying projects can increase the effectiveness of ecological restoration by establishing criteria for technical planning, implementation, monitoring and ongoing management of projects. They also provide a framework that facilitates stakeholder involvement and respects sociocultural realities and needs. These criteria have enormous potential to improve outcomes, assist agencies, companies and individuals involved in each aspect, guide policymakers in developing agreements for mandatory restoration and assessing compliance, or advise policymakers on the design, support, funding and evaluation of projects at any scale. Therefore, clear and specific standards can reduce the risk of negative impacts on ecosystems and biodiversity and help develop quality restoration projects and programmes.

The WWF-SER Standards and associated certification schemes are not "tick-box" exercises limited to verifying or measuring the process but require substantial recovery of ecosystem attributes and integrity, resulting in a lasting net gain in ecosystem services for people and the environment. The standards focus on the design and implementation phases and support and require post-implementation monitoring and ongoing management plans to ensure projects are stabilised and sustained.

BACKGROUND TO THE SER PRINCIPLES AND INTERNATIONAL STANDARDS FOR THE PRACTICE OF ECOLOGICAL RESTORATION

To improve the planning and implementation of ecological restoration projects and programmes, the Society for Ecological Restoration (SER) and its partners published the International Principles and Standards for the Practice of Ecological Restoration (McDonald *et al.,* 2016, Gann *et al*., 2019) (International Standards), which are fundamental to the design, implementation, monitoring and sustained management of ecological restoration projects at all scales and in all ecosystem types. They guide the restoration of degraded ecosystems worldwide, whether terrestrial, freshwater, coastal or marine.

The International Standards were developed through consultation with practitioners within the SER and peer review from the global scientific and conservation communities. The first edition was launched in 2016 at the United Nations Biodiversity Conference in Cancun, Mexico. This event brought together stakeholders from across the international policy arena, many of whom helped to drive global initiatives to implement large-scale environmental restoration programmes. As the International Standards were conceived as a living document to be modified and expanded through consultation and use, the launch invited these stakeholders to contribute to the document and promote its use more broadly. Subsequently, SER invited a diverse group of individuals and organisations to participate in the development of the document over several years, and the comments received were considered in the revision process. The second edition of the International Standards was published as a special issue in Restoration Ecology in September 2019 and will be revised and improved as the discipline evolves through science, practice and adaptive management. The second edition presents a robust framework for restoration projects to achieve their objectives while addressing challenges such as effective design and implementation, increased monitoring and documentation of complex ecosystem dynamics (especially related to climate change), and considering trade-offs associated with regulatory and ecosystem management priorities and requirements.

Reviewed by numerous experts, it is a key document cited by the UN Decade on Ecosystem Restoration strategy, has served as a framework for the development of the Decade Principles (FAO *et al*., 2022) and is cited as crucial guidance in other global standards, such as the Preferred by Nature's Ecosystem Restoration Standard. The International Standards provide general global guidance for ecological restoration, but the need for national, local, and thematic versions focused on specific sites or types of restoration has long been recognised. Some of these standards contributed to developing International Standards (e.g., the National Standards for the Practice of Ecological Restoration in Australia, McDonald *et al.,* 2016). Others were initially developed independently, such as these WWF-SER Standards, or were developed using the International Standards as a guide, e.g., *Guía práctica de restauración ecológica de la Fundación Biodiversidad para España* (Mola *et al*., 2018, "*Practical guide to ecological restoration of the Biodiversity Foundation for Spain"*).

The International Standards are compatible with and extend the Open Standards for the Practice of Conservation (Conservation Measures Partnership, 2013) and complement the REDD+ Social & Environmental Standards (REDD+ SES 2012) and other conservation standards and guidelines. Adoption has been widespread, with over 60,000 downloads from Restoration Ecology and over 900 citations to date.

BACKGROUND TO THE WWF STANDARDS FOR THE CERTIFICATION OF ECOLOGICAL RESTORATION PROJECTS FOR FORESTS

Work on the WWF-SER Standards began in 2010 under the leadership of WWF Spain, which organised a diverse team of forest restoration practitioners in Spain (Colomina and Melero 2016). Through a common and standardised methodology, it aimed to create standards to determine when a restoration project can be certified based on best practice criteria. Preliminary standards for forest ecosystem restoration in Spain were established in 2011 by a group of experts and subsequently applied in two projects in Castilla-La Mancha and Castilla y León on sites degraded by the impact of forest fires. The first edition of the Spanish forest restoration standards (version 1.0) emerged in 2012 based on the auditors' reports and suggestions from these pilot tests.

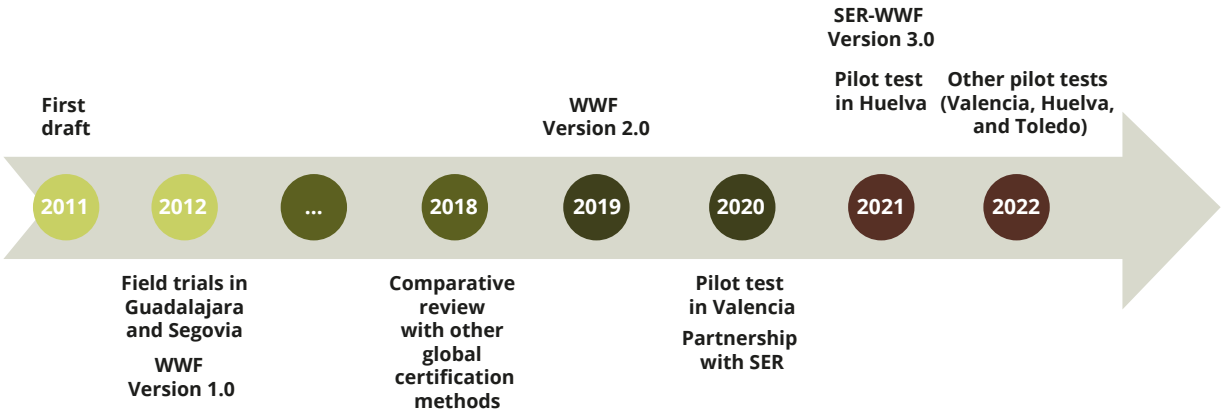
Twenty national restoration experts formed the Technical Work Group to develop the Standards (Work Group). They belonged to different disciplines and were linked to several professional fields (e.g., scientific community, public managers, private sector) to guarantee the standards' multidisciplinary character. The participants in the Work Group have changed slightly over time, and other partners have joined the process (e.g., auditors, more public managers). In 2018-2019, a new round of revisions was carried out, including a comparison between the 2012 and other standards and guidance for ecological restoration and best forest management practices (Cuenca, 2019). This review included the *IUCN: Ecological Restoration for Protected Areas* (Keenleyside *et al.*, 2014), the first edition of the International Standards (McDonald *et al.*, 2016) and the Spanish Forest Management Standard for Forest Stewardship Council certification (*Estándar español de gestión forestal para la certificación del Consejo de Administración Forestal, FSC 2018*). A new version of the Spanish standards (version 2.0) was published in July 2019 based on the comparative report and the expert group review.

DEVELOPMENT OF THE WWF-SER STANDARDS FOR THE CERTIFICATION OF ECOLOGICAL RESTORATION PROJECTS FOR FORESTS

The 2019 version of the WWF standards was made public at the 8th World Conference on Ecological Restoration, held in Cape Town, South Africa, where the second edition of the International Standards was also launched. At this event, the desirability of aligning WWF's work with that of SER became clear. Since 2020, WWF has partnered with SER to seek synergies and advance the development of a certification system for forest ecosystem restoration projects in Spain.

Work to align WWF's standards with SER's International Standards began in the summer of 2020 and generated a comparative analysis, including recommendations on how to align the two systems. Overall, the WWF standards aligned well with the International Standards, but there were areas where reorganisation and additional content were recommended. Two online sessions of the WWF Work Group were organised in April 2021 with the participation of 21 Spanish experts and international contributors from various fields related to restoration and SER representatives. The outcome of this and subsequent work led to a consensus and the publication of version 3.0 of the WWF-SER Standards in Spanish and English in January 2022. Following the publication of 3.0 and the incorporation of feedback from audits of pilot projects (see next chapter), another in-person meeting of the Work Group was held in February, 2023, resulting in additional improvement presented here. A figure showing the development over time of the WWF-SER Standards is shown below in Figure 1.

Figure 1. WWF-SER Standards development process



This document, the new WWF-SER Standards version 4.0, represents a case study of the application of the SER International Standards to forest ecosystem restoration in Spain, with the aspiration that they can be adapted and adopted by other countries in the Mediterranean region and support the development of a project certification system.

Consistent with International Standards, the WWF-SER Standards provide a tool to improve practices and outcomes for the ecological restoration of forest ecosystems in Spain, integrating ecological and socio-economic objectives. They can help ensure effective investment of funds and contribute to initiatives such as the *National Strategy for Green Infrastructure and Connectivity and Ecological Restoration* (*Estrategia Nacional de Infraestructura Verde y Conectividad y Restauración Ecológica*, IVCRE) in Spain, which requires that "standards for the certification of forest restoration works are routinely adapted and applied to guarantee the quality of interventions" (Valladares, 2017), and the European Union's proposed Nature Restoration Law, which would require the establishment of national restoration policies. These standards will allow progress to be made in the development and implementation of this proposed regulation, promoting synergies between the different criteria identified in it and ensuring that actions lead to the best possible way of doing restoration.

The development of the WWF-SER Standards and their alignment with the International Standards reflect the evolution of the discipline, with a particular emphasis on interventions that foster quality and maximise the ecological and social benefits of restoration impacts. This goal is achieved by basing projects on best practices through planning, implementation, ongoing management, and monitoring and evaluation. Ultimately, they aim to ensure restoration projects adhere to best practices from start to finish, based on criteria developed by a multidisciplinary team of national and international experts, with representatives from the scientific, technical, management, business and non-profit sectors, including restoration practitioners.

These standards recognise the reintroduction of fauna as a restoration tool. Renaturalisation or rewilding, is an innovative vision of nature conservation and ecological restoration that can significantly contribute to the recovery of degraded forest ecosystems, creating more heterogeneous areas with greater biodiversity. However, rewilding deserves to be addressed independently, and therefore it has not been explicitly addressed in V 4.0 of these standards. Future versions will also explore the role of national and European regulations and measures related to reducing greenhouse gas emissions and discuss how restoration projects can contribute to and incentivise a low carbon economy by facilitating and encouraging the use of carbon footprint calculations to address how ecological restoration projects can contribute to CO_2 removals. Finally, these standards do not address situations where disturbance is very intense, completely altering the functioning of the forest ecosystem, such as areas affected by mining. The socio-ecological characteristics of these areas, including their regulatory framework, call for specific standards (e.g., Young *et al.,* 2022).

PILOT PROJECTS USED TO VERIFY AND EVALUATE THE USE OF THE STANDARDS

External consultancies were used to verify and evaluate successive versions of the standards. They were applied in different development phases of three forest restoration projects in Spain. Independent audits were carried out to identify difficulties in the application and propose solutions for continuous improvement of the standards.

In 2019, the first pilot audit was conducted for the project *"Actions for the restoration of habitats of community interest in the ZEC Muela de Cortes and Caroig (Valencia)" ("Actuaciones de restauración de hábitats de interés comunitario en la ZEC Muela de Cortes y el Caroig (Valencia)")* (García-Pereira *et al.*, 2020), fostered by the Generalitat Valenciana and drafted by the public company VAERSA, to evaluate the planning and design phase and gather information on the effectiveness and practical use of the standards.

The philosophy of the restoration actions proposed by this work suited the projects covered by the standards, as it included restoration actions aimed at improving the services provided by the forest ecosystem, including the increase in biodiversity, improving the conservation status of forest habitats (in a broad sense), the configuration of a mosaic landscape more resistant and resilient to forest fires, drought and pests, the recovery of abandoned crop fields and the improvement of the pastoral value of the landscape.

The public company TRAGSA implemented the project between 2021 and 2022 with a budget of €1,144,139, co-financed by the Generalitat Valenciana and the European Regional Development Fund (ERDF). The implementation phase was audited with version 3.0 of the WWF-SER Standards.

Supported by the Regional Government of Andalusia, another pilot test was carried out to evaluate version 3.0 of the standards and audit the project *"Restoration plan for public forests affected by the Las Peñuelas fire 2017: western sector of Doñana Natural Park, Coto Mazagón and Ordenados de Moguer" (Plan de restauración de los bosques públicos afectados por el incendio de Las Peñuelas 2017: sector oeste de Doñana Parque Natural, Coto Mazagón y Ordenados de Moguer")* (Maneiro *et al.*, 2019). Both planning and implementation phases were evaluated. The project focused on public land affected by a large forest fire (8,500 hectares) and aimed to improve the conservation of flora, fauna, soil and ecosystems in a highly biodiverse national park.

In addition, in Yepes-Ciruelos (Toledo), LAFARGE HOLCIM ESPAÑA commissioned an external consultancy to evaluate the application of the standards in a forest restoration project developed by this company on the site of a former quarry. Although the scope of these standards does not include certain aspects of the restoration of mining sites (e.g., specific aspects of safety, monitoring of external contributions), the extent of the Yepes-Ciruelos quarry project, and its intent to assist recovery following natural plant succession and subsequent forestry use, made it possible to verify compliance with the standards in the forest restoration actions.

MOVING TOWARDS CERTIFICATION OF ECOLOGICAL RESTORATION PROJECTS FOR FORESTS

Effective implementation of forest restoration based on quality standards must be ensured to combat climate change, protect biodiversity and improve human well-being. The WWF-SER Standards for the certification of forest ecosystem restoration projects in Spain contribute to this effort by providing a solid, real-world-tested framework for developing and launching a certification system for ecological restoration projects in the near future. SER, WWF and other partners will continue collaborating to improve these standards and move forward with plans to launch a broader project certification system in the coming years. The work builds on WWF's

investment in forest ecosystem restoration standards in Spain and SER and SER-Europe's contributions to regional and global standardisation and certification programmes.

This programme will provide guidance, structure and an audit process for designing, implementing and financing standards-based ecological restoration to achieve the best ecological and social outcomes. This programme aims to develop and test a quality "certification seal" for ecological restoration, similar to the certification of sustainable forest management, for example. Finally, to ensure its success, work is being done to make it feasible, operational and affordable in terms of human, material, financial and time resources. A cost-benefit analysis of projects audited following WWF-SER Standards is being developed to contribute to the objective of building a successful certification programme.

STRUCTURE OF THE STANDARDS

Section 2 comprises the details of the WWF-SER Standards for the Certification of Forest Ecosystem Restoration Projects in Spain and several annexes with supporting (non-binding) materials, including a detailed list of recommended verifiers for evaluating the established indicators, a proposal of contents for the reports of forest ecosystem restoration projects and a summary of the reference legislation on which this document is based. In addition, a list of acronyms and abbreviations is included at the beginning of the document and a glossary at the end to facilitate a clear and manageable reading of the standard. Significant definitions found in the annexes have also been included in the glossary. Reference to the most recent addition of the SER International Standards is recommended as required.

STANDARDS FOR THE CERTIFICATION OF ECOLOGICAL RESTORATION PROJECTS FOR FORESTS IN SPAIN

The WWF-SER Standards are organized around three general Principles. For each Principle, several **criteria** are described with their corresponding **indicators**. Annex 1 lists the verifiers that can be evaluated, not being binding since they are only informative to facilitate the search for compliance with the standards.

1. PLANNING AND DESIGN

A forest ecosystems restoration (FER) project includes an assessment phase, which justifies the need for analysis and identifies the factors that must be considered to re-establish natural processes that characterise reference ecosystems and integrate social interests. Proposals for action are in line with the assessment and with the properties of the reference ecosystems. The FER project is structured and described in a specific technical document to guarantee its application.

1.1. Context Analysis

A justified boundary and description of the area to be restored is included, considering how it integrates with its surroundings. The FER project is compatible with the sociocultural heritage and the legal context and with the history of the site and its immediate surroundings.

1.1.1. *Geographical analysis*

The area to be restored is geographically located and spatially defined, and there is a description of its relationship with its social and ecological environment, particularly regarding ecological connectivity, describing where and how it can be improved. Strategies to guarantee continuity through future management are specified; the objective is to align with and integrate the FER project in the management of surrounding ecosystems and landscapes.

1.1.2. *Sociocultural analysis*

The sociocultural context and the cultural heritage of the area to be restored are described.

1.1.3. *Local and traditional knowledge*

Relevant and specific local, traditional and scientific knowledge are considered and documented.

1.1.4. *Environmental regulations*

The FER technical report includes a ***list*** of the applicable environmental regulations ***(according to Annex 3)*** and an analysis of the most relevant aspects. The project report is coherent and does not contradict local, regional or national ***rules*** or strategic instruments.

1.2. Baseline inventory and assessment

The baseline inventory includes an assessment of the unique features of the area to be restored and the main drivers of degradation.

1.2.1. *Description and assessment of the unique features of the area*

A description and assessment of the unique features of the area to be restored, in the context of global change, include: geology, physiography, hydrogeology, soils, flora and fauna, vegetation, habitats and microhabitats, community dynamics, disturbance regime (fires, floods, erosion processes and herbivory), threatened species and habitats, social environment and cultural heritage affected by the FER. Ecological aspects are linked to key ecosystem attributes, reference ecosystems and restoration objectives.

1.2.2. *Land use changes*

The temporal sequence of land use changes is described, and the causes, intensity and extent of degradation are detailed. The impact of land use changes on biophysical conditions and organisms is described in terms of key ecosystem attributes.

1.2.3. *Processes limiting spontaneous ecosystem recovery*

Processes limiting the spontaneous recovery of degraded or destroyed ecosystems are identified, with an analysis of soil characteristics and key, dominant and focal species. Opportunities to enhance spontaneous recovery are identified.

1.2.4. *Prediction of the evolution of the ecosystem without intervention*

A prediction of the evolution of the degraded ecosystem without intervention is included, considering the most likely environmental and socio-economic scenarios. This assessment includes changes in structure, composition and functioning that will likely occur if no restoration activities are carried out and justifies the need for restoration and the proposed restoration activities.

1.2.5. *Distinct restoration areas*

Distinct restoration areas are identified within the area to be restored according to the extent and heterogeneity of the project area, and based on this zoning, priority areas for action are established.

1.3. Assurance of land availability

Those responsible for the FER project provide evidence of the availability of the land to be restored.

1.3.1. *Availability of land to be restored*

The availability of the land to be restored is documented through formal agreement of the owners or their authorised managers to carry out the corresponding restoration activities, monitoring, evaluation and ongoing management.

1.3.2. *Administrative requirements*

Administrative requirements (authorisations, permits) that stem from the legal framework are met.

1.4. Commitment to Compliance with Standards

Those in charge of the FER project show a long-term commitment to adhere to the principles and criteria of the FER.

1.4.1. *Commitment to compliance with standards*

Responsible for the FER project and landowners or their authorised managers sign a commitment to comply with the FER standards and to grant access to the area to carry out restoration tasks and long-term monitoring and ongoing management.

1.5. Stakeholder participation

Participation is meaningful, informed and equitable. It is preferably carried out from the onset of the planning stage of the FER project and maintained during all later phases. The FER project includes a stakeholder participation and communication plan designed according to the project's goals, scale and intensity, which incorporates all stakeholders including land and water owners, users and managers and, as appropriate, representatives of the economic sectors and members of the local community affected by the project.

1.5.1. *Identification of stakeholders*

Stakeholders and their feedback are identified and described. Social needs for ecosystem services is analysed according to the objectives, scale and intensity of the project (according to 1.5.2 and 3.1.3). Gender equality and gender balance are promoted.

1.5.2. *Participation calendar*

A calendar for key stakeholder participation covering the entire duration of the project is included.

Participatory planning and group design of the restoration plan are promoted. The FER project managers open a consultation period and provide a restoration project summary document, aftercare and ongoing management and monitoring plan and evaluation plan to the stakeholders. There is also a mechanism for receiving and integrating comments and suggestions during the design of the FER project.

Participatory processes that may include training activities for local people are developed in subsequent project phases.

1.5.3. *Potential conflicts*

Potential conflicts between key stakeholders are recorded and evaluated, and mechanisms to resolve them are proposed.

1.6. Reference ecosystems

Reference ecosystems (RE) are identified for each distinct restoration area. Restoration goals and objectives are formulated, and the natural processes necessary to achieve them are supported.

1.6.1. *Characterisation of reference ecosystems*

RE, including appropriate semi-natural systems, that integrate ecological dynamics, spatial variability of the landscape and social interests, are identified and characterised, and goals and objectives are set for each. The biodiversity to be restored (including relevant species, communities and landscapes) is identified.

1.6.2. *Characterisation of ecosystem services*

The provision of ecosystem services (supporting, regulating, provisioning cultural) to be maintained or enhanced by the FER project are identified and characterised. The criteria for selecting and prioritising ecosystem services for this purpose are thoroughly explained.

1.6.3. *Compatibility of reference ecosystems*

RE are compatible with the history of the region and the dynamics of communities and ecosystems in the context of global change.

1.6.4. *Restoration goals and objectives*

Goals and objectives FER project are identified. The restoration objectives are formulated in terms of measurable indicators, which allow for assessment throughout the project. The indicator system should report on six key ecosystem attributes[1]: (i) removing pressures and threats causing degradation, (ii) recovering abiotic conditions, (iii) recovering species composition, (iv) recovering ecological structure, (v) recovering ecological functions, and (vi) restoring connectivity and biotic and abiotic exchanges with the surrounding landscape.

1.7. Design and logistics of proposals for actions

Proposals for restoration actions addressing potential solutions to the problems identified are described in sufficient detail. The technical and ecological feasibility of the proposed actions are justified, and the use of economic and technical resources are optimised.

1.7.1. *Proposals for actions*

In each distinct restoration area, the proposals for actions are sufficiently detailed and derive from analysing the different options considered in the definition of goals and objectives.

1.7.2. *Justification of selected restoration options*

A justification of the selected restoration options is included, and it is based on the existing conditions, including temporary ones, and the human and financial resources for each option.

1.7.3. *Human resources*

The human resources involved in the planning and design of the FER are appropriately qualified.

1.7.4. *Machinery and other material resources*

The proposals for actions define the needs of the machinery and further material resources.

1 Gann *et al.*, 2019

1.7.5. *Schedule*

The temporal sequence of the restoration actions, set out in a schedule, follows all natural and regulatory constraints (e.g., nesting, seasonal senescence in plant growth, fire risk).

1.7.6. *Budget*

The FER project budget includes the work units required for the implementation, monitoring, evaluation and aftercare and ongoing management. Sufficient funding has been secured for the planned activities for a period that is ecologically meaningful (according to 1.9).

1.7.7. *Risk assessment*

The planning comprehensively assesses the risks associated with implementing the FER project and identifies strategies to manage them, including, in particular, procedures for dealing with unexpected changes in environmental conditions, funding and human resources.

1.8. Ecological protection of the site

Limited or short-term negative impacts may be accepted if they do not hinder the long-term recovery of the ecosystem being restored. Those responsible for the FER project must justify using synthetic chemicals, biological control agents or exotic species according to regional and national regulations and internationally accepted scientific protocols. The FER project does not use genetically modified organisms.

1.8.1. *Potential negative impacts arising from restoration actions*

All restoration actions respect natural processes (including natural disturbance regimes, food webs, dispersal and colonisation) and promote and protect the potential for natural and assisted recovery. Planning includes an analysis of the potential adverse environmental and social effects of restoration actions and the development of preventive measures to mitigate them.

1.8.2. *Biological control*

The use of any biological control agent shall be selective and adjusted to the circumstances of the project, ensuring its use is supported by legal regulations.

1.8.3. *Use of synthetic chemicals*

The use of synthetic chemicals in the project is minimised and justified.

1.8.4. *Emergency protocols*

If chemical products are used, the project includes an emergency protocol that documents the actions for monitoring, controlling, and correcting potential hazards, such as accidental spills and collateral damage.

1.8.5. *Use of exotic species*

The use of exotic species is avoided, except in cases that are strictly necessary and adequately justified in the project plan, and provided these species are not invasive or potentially invasive in the region.

1.8.6. *Genetically modified organisms*

Genetically modified organisms are not used.

1.9. Aftercare and ongoing management

There is a minimum level of aftercare (up to 5 years after major implementation activities have been completed) and ongoing management (beyond 5 years) until the restoration goals and objectives have been achieved.

1.10. Monitoring and evaluation

A monitoring and evaluation plan is established to account for what is projected and implemented. Its purpose is to r.eport on achievement using measurable indicators and allow for adaptive management.

1.11. Information management

Procedures are defined to guarantee the accessibility, public dissemination, and custody of the information, including all relevant documentation.

1.12. Reports

A technical document containing the relevant information for planning and designing the FER project, as needed to implement and evaluate it, is prepared (according to Annex 2).

1.12.1. *Technical report:*

There is a specific technical document which contains the following:

- Main body of report
- Drawings
- Schedule
- Budgets
- Technical specifications (as appropriate)
- Stakeholder participation and communication plan
- Aftercare and ongoing management
- Monitoring and evaluation plan. This documentation is coherent and contains complementary information sufficient to justify, plan, execute and evaluate the FER project.

In addition, the specific technical report will include health, safety, waste management and environmental impact studies when necessary.

2. IMPLEMENTATION

The FER project is carried out following the requirements of the technical planning document.

2.1. Ecological protection of the site

Responsible for the FER shall take measures to avoid and mitigate potential adverse environmental and social impacts of restoration actions. They shall also strictly control and document the use of any synthetic chemical, biological control agent or exotic species used by the project.

2.1.1. *Potential negative impacts*

Measures are implemented to prevent, mitigate and remedy potential environmental and social impacts, especially those important due to the magnitude, becoming permanent or the long-term impact. This impact assessment is recorded in the project implementation document (Annex 2).

2.1.2. *Chemical and biological control documentation*

A list of all chemicals and biological control agents is kept, and information is collected on the positive and negative effects of their application.

2.2. Hiring of suitable personnel

The personnel involved in the implementation of the FER project are appropriately qualified.

2.2.1. *Personnel Involved in the FER Project*

All personnel involved in the FER project have the experience, training and/or classification, technical qualification, or certification technically required by the project. Depending on the magnitude of the project, the following may be required:

- A technical manager appointed by the lead managers of the FER project, with the required technical qualifications, who guarantees and certifies that all the restoration actions are carried out according to the technical conditions of the project.
- A technical manager appointed by the performing company with the required technical qualification who directs the implementation according to the technical requirements of the project.
- An on-site implementation manager who organises and distributes the restoration works and transmits all the orders received by (i) or (ii) to the rest of the implementation staff.

2.2.2. *Recruitment options and requirements*

If the FER project receives public funding, competition conforms to the recruitment processes required by the funding agency.

Otherwise, local recruitment options can be prioritised to boost labour and social activity in local communities where restoration actions are carried out.

2.3. Specifications of machinery and materials

The material resources involved in implementing the FER project meet the specifications required in the technical planning document.

2.3.1. *Specifications*

The machinery and other material resources comply with the specifications required in the technical planning document. The technical manager must approve any modifications and record them in the project implementation document.

2.3.2. *Regulatory requirements, delivery and handling of plant material*

The reproductive plant material used in the restoration must comply with the requirements set out in the corresponding legislation and the technical conditions described in the project.

The receipt of plant material on site is documented, and there is a control of the requirements mentioned above which must be properly included in the project implementation document. Likewise, there is evidence of the correct handling of this material on site.

2.4. Compliance with planning and design

The FER project is implemented based on the technical planning document.

2.4.1. *Contracts, agreements, and conditions*

The FER project is implemented according to the conditions stated in the project, the contracts and the agreements.

2.4.2. *Preliminary documentation*

Depending on the scale of the FER project, these actions are carried out before the works start: (i) the site layout verification documentation, where the spatial dimensions and the availability of the land are verified on the ground, as is the technical feasibility for implementing the FER; (ii) project implementation document; (iii) the works plan, stating the implementation periods planned for the different phases of the project; and (iv) the health and safety plan. These actions are documented by those responsible for the FER (lead and executing organisation).

2.4.3. *Quality control*

There is documentary evidence of having passed the quality control to the specifications set in the project by the lead organisation in every one of the FER phases.

2.4.4. *Modifications*

If any action in the FER project is not carried out following the project specifications, the lead managers will define any needed corrective measures and provide evidence that the modifications made, or corrective measures required, respect the original project goals. All modifications are duly documented in the implementation document. Stakeholders must be notified, and the modifications or corrective measures legally approved, if necessary.

If modifications are made based on adaptive management, then the project plan should be adjusted to reflect those modifications, including any modifications to project goals if needed.

2.5. Compliance with environmental, labour and health and safety regulations

The FER project is implemented in compliance with the legal requirements regarding environmental, labour and health and safety regulations.

2.5.1. *Compliance with environmental laws and regulations*

The FER project is implemented in compliance with environmental laws and regulations (according to Annex 3).

2.5.2. *Contract*

The FER project is implemented in compliance with any contracts for the development of the project.

2.5.3. *Compliance with labour regulations*

Labour regulations are complied with, including gender equality, non-discrimination, syndical freedom and syndication.

2.5.4. *Compliance with health and safety regulations*

The FER project complies with health and safety regulations.

2.5.5. *Compliance with regulations governing volunteers*

The regulations governing volunteers, if any, are complied with.

2.6. Communication with key stakeholders

Key stakeholders, including the local community, are informed of any action which may affect their interests and are provided with communication channels to present their comments and suggestions to those responsible for the FER project. Likewise, they may participate in the implementation, aftercare, ongoing management, monitoring and evaluation phases when possible.

2.6.1. *Compliance with regulations on information and public participation*

The current information and public participation regulations are complied with during the implementation phase.

2.6.2. *Consultation period*

Those in charge of the FER project have created a mechanism to receive and include stakeholders' comments and suggestions during the implementation of the project.

2.7. Documentation

While implementing the FER project, all orders, incidents, modifications that occur during the development of the project will be recorded in the project implementation document.

For future consultation, the outcome of the implementation is recorded in a document or report on actions, which includes the details of the restoration actions carried out, the implementation dates of each phase of the project, measurements and geographic information.

3. MONITORING, EVALUATION, AFTERCARE AND ONGOING MANAGEMENT

The FER applies the protocols provided in the technical plan for monitoring and evaluation. The main purpose is to verify the level of recovery achieved in relation to the goals and objectives, including key reference ecosystems (RE) attributes. Aftercare and ongoing management actions are carried out according to the plan or are adaptively managed based on relevant monitoring data.

3.1. Monitoring in an adaptive management framework

The protocols established in the monitoring and evaluation plan are developed in order to:

- Report through measurable indicators on compliance with the goals and objectives and possible modifications.
- Inform and facilitate adaptive management
- Disseminate the project outcomes to stakeholders
- Promote, as appropriate, collaboration with the scientific community.

3.1.1. *Measurement of indicators in an adaptive management framework*

The indicators in the monitoring and evaluation plan are measured periodically following the monitoring protocols and schedule. The FER project must respond to any significant changes detected, including those caused by natural disturbances or climate change, by applying adaptive management measures. This includes corrective measures to adapt to unexpected ecosystem responses, whether positive or negative, as well as carrying out additional monitoring, if necessary.

3.1.2. *Control and test plots*

Control and test plots. Control plots, test plots for new techniques, or plots subjected to alternative treatments are established as appropriate. Their outcomes will be reviewed to contrast the quality of the works, monitor the trajectory and compare alternative techniques, should the scale and characteristics of the project deem this appropriate.

3.1.3. *Monitoring results*

The monitoring results are periodically analysed and used to evaluate the project, including measuring the trajectory towards the goals and objectives set and improvement compared to the baseline conditions. Multi-criteria analysis tools such as the 5-star system and the ecological recovery wheel[2] are recommended for this evaluation.

3.1.4. *Documentation file*

An adequate system to store all relevant reports, documents, maps, audio-visuals, and data generated in the monitoring and evaluation activities is kept and regularly updated. This system should be digital and open for consultation.

3.1.5. *Communication of results*

The stakeholders are regularly informed of the main results of monitoring and evaluation in an accessible way. The results are also provided to researchers and restoration experts via appropriate platforms (e.g., web platforms, brochures, congresses, scientific publications). Where appropriate, training activities for the local community are included to encourage their engagement in long-term monitoring, collaborative knowledge co-generation and dissemination.

3.1.6. *Monitoring personnel*

The personnel monitoring and evaluating the FER project have the appropriate qualifications.

2 Gann *et al.*, 2019

3.2. Aftercare and ongoing management

Aftercare and ongoing management actions are carried out as foreseen in the project planning and integrate the results of monitoring.

3.2.1. *Development of aftercare and ongoing management plan*

Aftercare and ongoing management actions to achieve restoration goals and objectives are implemented, and measures are adopted to prevent reversal of restoration achievements while preventing maintenance tasks from becoming permanent.

3.2.2. *Financial commitment*

A financial commitment ensures the implementation of aftercare and the ongoing management of the FER.

3.2.3. *Updates*

The aftercare and ongoing management plan will be updated after project completion and analysis of monitoring results.

3.2.4. *Modifications*

Aftercare and ongoing management activities not on the original plan and when they are or should be implemented must be appropriately justified and recorded. If modifications are made based on adaptive management, then the plan should be adjusted to reflect those modifications, including any modifications to project goals if needed.

3.2.5. *Aftercare and ongoing management of personnel*

The personnel involved in aftercare and ongoing management of the FER have the appropriate qualifications.

ACRONYMS

CDB: United Nations Convention on Biological Diversity

EU: European Union

ERDF: European Regional Development Fund

FAO: Food and Agriculture Organization of the United Nations

FER: Forest Ecosystem Restoration Project

FSC: Forest Stewardship Council

IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IUCN: International Union for Conservation of Nature

IVCRE: National Strategy for Green Infrastructure and Ecological Connectivity and Restoration (Spain)

MITERD: Ministry for Ecological Transformation and the Demographic Challenge (Spain)

OECM: Other Effective Area-Based Conservation Measures

SDG: United Nations Sustainable Development Goals for 2030

SECF: Spanish Society of Forestry Sciences

SERE: Society for Ecological Restoration, European Chapter

UNCCD: United Nations Convention to Combat Desertification

UNESCO: United Nations Educational, Scientific and Cultural Organization

UNFCCC: United Nations Framework Convention on Climate Change

GLOSSARY

This glossary includes the terms and definitions used throughout the document, both in the standard and in the supplementary annexes. Wherever possible, accepted reference definitions have been used from a limited number of sources, identified in the definition itself in most cases[3].

Adaptive management measures: A system of periodic learning, review and adjustment of all restoration management decisions for evaluation in the light of new research, new data in the monitoring plan or any other new information (adapted from SER, FAO, FSC, IUCN). Adaptive management measures are the specific management readjustment actions that are put forward for this purpose.

Assisted regeneration: An approach to restoration that seeks to actively stimulate the regenerative capacity of organisms present in the area to be restored or adjacent to it. It differs, therefore, from active reintroduction of organisms and undisturbed natural regeneration. Although this methodology is often applied to areas with low to medium levels of degradation, even some heavily degraded areas could recover through assisted regeneration with appropriate treatments and timing. Interventions may include pest removal, recovery of disturbance regimes and installation of resources to promote colonisation.

Baseline: Biotic and abiotic elements of the area to be restored prior to restoration, including their structural, functional and compositional attributes and current condition.

Biodiversity: The number and variety of living things that inhabit the Earth, as well as the diverse ecosystems in which they live and the genetic differences within each species (according to the International Convention on Biological Diversity).

Certification: Result of the process by which compliance with the requirements defined in the standard is verified and documented.

Classification: Companies wishing to tender with the public sector must be previously classified in an Official Register of Project Bidders and Classified Companies for works whose estimated value of the contract reaches certain thresholds.

Composition (of an ecosystem): Variety of organisms in an ecosystem (according to SER).

Connectivity: The ability of a population or set of populations of a species to, among other ecological processes, move and interact with individuals of another population in a fragmented territory. Ecological connectivity can also be defined as the ability to connect similar ecosystems in a fragmented landscape.

Criterion/criteria: A specific means of assessing compliance with a principle.

Cultural heritage: The cultural heritage of a community's past, maintained to the present day and passed on to future generations. Tangible heritage includes monuments, buildings, sculptures, paintings, objects, documents, etc. Intangible heritage refers to practices, expressions, knowledge or techniques transmitted by communities from generation to generation (according to UNESCO).

Degradation (of an ecosystem): Consequence of one or more negative impacts on an ecosystem resulting in the loss of biodiversity and the simplification or disruption of its structure, composition and function.

Distinct restoration area: In the context of a FER project, these are areas contained within the study and/or intervention area that have a certain homogeneity of ecological or environmental factors, such as physiography, lithology, edaphology, floristic or faunistic composition, microclimate or land use.

3 For more definitions, see the Glossary of terms in Gann *et al.*, 2019.

Document or report on actions: after implementing the FER project, document where those responsible for the REF collect the details of the restoration actions carried out, the dates of execution of each of the phases of the project, measurements and geographic information.

Ecological functionality: See "function".

Ecological restoration: Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (according to SER). Ecosystem restoration is sometimes used interchangeably with ecological restoration, but ecological restoration always addresses biodiversity conservation and ecological integrity, whereas some approaches to ecosystem restoration may focus solely on the delivery of ecosystem services.

Ecosystem services: Processes through which nature produces beneficial outcomes for humans. They can be supporting (nutrient cycling, soil formation, etc.), provisioning (water, food, fibre and wood, fuel), regulating (climate regulation, water cycle regulation) and cultural (aesthetic, spiritual, educational, recreational). According to IPBES, ecological restoration, among other actions, is essential for the safeguarding of biological diversity and ecosystem services and functions.

Forest ecosystem/woodland: In Spain, the concept of forest ecosystem ("monte" in Spanish) aligns more closely to the term woodland, as defined in Article 5 of Law 43/2003 on Forestry ("Ley de Montes", in Spanish). In this respect, the term is understood as "any land on which there is growth of tree, shrub, bush or herbaceous species, whether spontaneously or as a result of sowing or planting, which fulfil or may fulfil environmental, protective, productive, cultural, landscape or recreational functions" (more information in Section 1.1.1).

Function (of an ecosystem): The function or functioning of an ecosystem results from the interactions and relationships between biotic and abiotic elements and includes processes such as primary production, decomposition, nutrient cycling and transpiration, as well as emergent properties such as competition and resilience. Functions represent the potential of the ecosystem to provide services and goods to humans.

Habitat: Place where a species, animal or plant, or a population lives and develops, when considering not only the physical space, but also its ecological characteristics (according to the Spanish Society of Forestry Sciences - SECF).

Indicator: A measurable variable that specifically and objectively assesses the fulfilment of a criterion.

Intensity: A measure of the power, severity or strength of the impact of restoration actions on environmental and social values.

Intervention: Any action or treatment aimed at promoting the recovery of an ecosystem or component of an ecosystem.

Key ecosystem attributes: Attributes used to identify reference ecosystems, as well as for baseline assessment, formulate restoration objectives and check the level of recovery achieved, including absence of threats, species composition, community structure, physical conditions, ecosystem functions and external exchanges (adapted from SER).

Keystone species: Species that are not very abundant, but important for their role in the functioning of the system.

Landscape: A terrestrial mosaic of natural ecosystems, production systems and spaces for social and economic use that interact with each other.

Leakage: Degradation prevented at a restoration site that moves beyond the restoration site, either in whole or in part.

Local ecological knowledge (LEK): Knowledge, practices and beliefs gained through personal empirical observation and interaction with local ecosystems.

Microhabitat: The smallest part of an ecosystem containing a distinctive flora and fauna.

Multifunctionality: From an ecological perspective, multifunctionality is an ecosystem characteristic, resulting from its functioning, and consists of the capacity to provide multiple ecosystem goods and services to humans. It is the basic principle of forestry, which is why forest management should aim to provide all the benefits for society as a whole that it can offer (according to the SECF).

OECM areas (Other Effective Area-based Conservation Measures): A geographically defined area, other than a protected area, that is governed and managed to achieve positive and sustained long-term outcomes for the in-situ conservation of biological diversity, with associated ecosystem functions and services and, where appropriate, cultural, spiritual, socio-economic or other locally relevant values.

Ongoing management: Activities applied after the restoration objectives have been achieved in order to counteract ecological degradation processes to sustain ecosystem attributes with minimum intervention (adapted from SER).

Parties responsible for the FER: The owner of the land to be restored that will be responsible for the restoration project. The owner may delegate the responsibility to the manager or the entity executing the restoration project, provided that both parties are in agreement and this is recorded in writing.

Principle: Rule or essential element of the standard. It is the development of the overall objective of the standard and divides it into meaningful parts.

Project implementation document: Document in which those responsible for the FER project record all activities, orders, incidents, modifications that occur during the implementation of the project.

Reference ecosystem: A representation of a native or semi-natural ecosystem targeted for ecological restoration. It generally represents a non-degraded version of the complete ecosystem with its flora, fauna and other biota, abiotic components, functions, processes and successional stages that might have existed at the restoration site in the absence of degradation, adjusted to adapt to changing or anticipated environmental conditions (adapted from SER).

Regeneration (natural or spontaneous): After removal of impact sources (without active intervention), any process of re-establishment of biota (flora, fauna and microbiota), whether arising from colonisation or in-situ processes such as germination, birth or any other form of recruitment (adapted from SER).

Renaturalisation or *rewilding*: The process of rebuilding, following major human disturbance, a natural ecosystem by restoring natural processes and the complete or near complete food web at all trophic levels as a self-sustaining and resilient ecosystem with biota that would have been present had the disturbance not occurred (Carver, 2021).

Restoration activities: Activities (including ecological restoration) that reduce degradation or improve conditions for partial or full ecosystem recovery. Sometimes described as a "family" of interrelated restoration activities (adapted from SER).

Restoration approach: SER identifies three potential approaches based on the degree of ecosystem damage to be restored, which can be used in combination or individually: (i) natural regeneration, (ii) assisted regeneration and (iii) reconstruction. The approach may therefore vary for each of the different distinct restoration areas identified.

Scale: Refers to the size or extent of the site to be restored.

Semi-natural ecosystem: In the EU legal context these are the ecological systems of biodiversity created by human activities (e.g. in Spain, semi-natural grassland-woodland formations known as "dehesas", etc.). They have evolved through traditional pastoral and agricultural or other human activities that may be centuries old and depend on traditional management to maintain their characteristic composition, structure and functioning. These ecosystems are highly valued for their biodiversity and ecosystem services and can be a reference for ecological restoration (adapted from SER).

Species (desired species): Species of the reference ecosystem (or sometimes non-native nurse species), which will allow the local natural or semi-natural ecosystem to recover (adapted from SER).

Species (dominant species): Abundant species that therefore have a significant effect on the functionality of the system.

Species (environmentally degrading species): Species whose presence reduces some indicators of system functionality, such as productivity.

Species (exotic/non-native): Species and subspecies (including their parts, gametes, seeds, eggs and propagules that could survive or reproduce), introduced outside their natural distribution and potential dispersal area, which they would not have been able to occupy without direct or indirect introduction, or without human care (according to the Spanish Catalogue of Invasive Exotic Species).

Species (invasive exotic/non-native species): Those exotic/non-native species that are introduced or become established in a natural or semi-natural ecosystem or habitat and that are an agent of change and threat to native biological diversity, either because of their invasive behaviour or because of the risk of genetic contamination (according to the Spanish Catalogue of Invasive Exotic Species).

Species of special interest: Species that are rare, threatened, endemic or of interest to the local community for any duly justified reason.

Species (unwanted species): Exotic/non-native, invasive, environmentally degrading species, characteristic of unwanted successional trajectories.

Stakeholders: Any individual or group affected or interested directly or indirectly by the actions planned in the FER project (according to the Fundación Biodiversidad).

Stand: portion of forest land that has similar characteristics and that is distinguished from what surrounds it.

Standard: A set of guidelines, rules, parameters and means of verification that define the optimum level for the implementation of a forest ecosystem restoration project.

Structure (of an ecosystem): Physical organisation of an ecological system, including density, stratification and distribution of species, canopy structure and the pattern of habitat patches, as well as abiotic elements.

Succession (ecological): A process or pattern of replacement or development of an ecosystem after a disturbance (adapted from SER).

Successional trajectories: Successional or ecological trajectories describe the projected pathways for the development of ecological, biotic and abiotic attributes of an ecosystem over time. In FER projects, the trajectory starts with a degraded ecosystem and progresses towards the desired recovery state described in the project objectives and is often based on a reference ecosystem (adapted from SER).

Technical report: Technical document containing all the information on the planning and design of the FER project necessary for its implementation and evaluation.

Traditional ecological knowledge (TEK): Knowledge and practice passed down from generation to generation and informed by strong cultural memory, sensitivity to change and values including reciprocity (adapted from SER).

Uniqueness: A characteristic, quality or detail that distinguishes a living being or thing from others of the same kind or type.

Verifier: Source of information for an indicator or for its reference value. Describes by what means compliance with an indicator can be verified and documented.

Works plan: set of processes, procedures and documentation necessary to plan, develop, manage, execute and control the project schedule.

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ANEXES

ANNEX 1. VERIFIERS

Verifiers that can be assessed are listed below by indicator to facilitate the search for compliance with the standards. Appropriate verifiers will vary from project to project.

1. *Planning and design*

1.1. Context analysis

1.1.1. Geographical analysis

Verifier:

a) FER technical report.

1.1.2. Sociocultural analysis

Verifiers:

a) FER technical report

b) List of historical documentation inquired (literature, paintings, etc.) or scientific literature used

c) Archaeological reports from the competent administrations, if there are cultural assets to be protected

d) Report on the social research process and/or communication records with stakeholders (local communities, universities, etc.). Report on the social research process

e) Environmental or landscape perception studies

1.1.3. Local and traditional knowledge

Verifier:

a) FER technical report

b) Identified stakeholders and results of interviews on local and traditional knowledge

c) List of documentation consulted or bibliography

1.1.4. Environmental regulations

Verifier:

a) FER technical report

b) Current applicable regulations (Annex 3)

1.2. Baseline inventory and assessment

1.2.1. Description and assessment of the unique features of the area

Verifier:

a) FER technical report

1.2.2. Land use changes

Verifier:

a) FER technical report

1.2.3. Processes limiting spontaneous ecosystem recovery

Verifier:

a) FER technical report

1.2.4. Prediction of the evolution of the ecosystem without intervention

Verifier:

a) FER technical report

1.2.5. Distinct restoration areas

Verifiers:

a) FER technical report

b) Project drawings

1.3. Assurance of land availability

1.3.1. Availability of land to be restored

Verifiers:

a) Documents accrediting ownership: simple extract of the land registry, cadastral certificate, title deeds of the land and registration in the Catalogue of Public Utility Forestry

b) Documents accrediting long-term lease: lease contract registered with the Treasury, agreements, consortiums, plenary agreements and land stewardship agreements

c) Third-party authorisation for the restoration

d) FER technical report

1.3.2. Administrative requirements

Verifiers:

a) Administrative permits: approval for the restoration by the regional administration with competence in forestry matters; authorisation from the hydrographic confederation for the action in the public watercourse area; building permit from the municipality where the land is located (if the restoration includes any work subject to a minor building permit, such as the installation of enclosures)

b) FER technical report

1.4. Commitment to compliance with standards

1.4.1. Commitment to compliance with standards

Verifier:

a) Commitment letter signed by the lead manager

b) Other certified projects

1.5. Stakeholder participation

1.5.1. Identification of stakeholders

Verifiers:

a) List of stakeholders engaged

b) Requests for information from stakeholders

c) Reports on stakeholder surveys

d) Records and minutes of meetings held with stakeholders and analysis of their requests

e) FER technical report

f) Stakeholder participation and communication plan

1.5.2. Participation calendar

Verifiers:

a) Interviews with stakeholders

b) Records and minutes of meetings, dissemination activities or participation activities carried out with stakeholders, key actors and the local population. Citizen participation councils

c) FER technical report

d) Stakeholder participation and communication plan

1.5.3. Potential conflicts

Verifiers:

a) Record of complaints and suggestions provided and their follow-up

b) Conflict resolution procedures

c) Minutes of meetings

d) FER technical report

e) Stakeholder participation and communication plan

1.6. Reference Ecosystems

1.6.1. Characterisation of reference ecosystems

Verifiers:

a) FER technical report

b) Project plans: Mapping of reference ecosystems consistent with the assessment zoning

c) Historical and landscape analyses and other criteria supporting the choice

1.6.2. Characterisation of the ecosystem services

Verifier:

a) FER technical report

b) In-situ quantification of ecosystem services through remote sensing or modelling

1.6.2. Compatibility of reference ecosystems

Verifiers:

a) FER technical report

1.6.3. Restoration goals and objectives

Verifiers:

a) FER technical report

b) Key ecosystem attributes reported under the indicator system in the FER

1.7. Design and logistics of proposals for actions

1.7.1. Proposals for actions

Verifier:

a) FER technical report

1.7.2. Justification of selected restoration options

Verifiers:

a) FER technical report

b) Project budget

c) Scientific, local and traditional knowledge-based evidence on the best restoration practices

1.7.3. Human resources

Verifiers:

a) FER technical report

1.7.4. Machinery and other material resources

Verifiers:

a) FER technical report

a) Technical specifications document

1.7.4. Schedule

Verifiers:

a) FER technical report

b) Project schedule

c) Administrative authorisations of the competent administrations, recording whether temporal or spatial restrictions have been established due to nesting, sprouting stops, fire risk, etc.

d) Justification based on the temporality of the ecological and social processes

1.7.5. Budget

Verifiers:

a) FER technical report

b) Project budget broken down by actions and years

c) Financial guarantees (grants, committed resources, etc.)

d) Commitment letter signed by the lead managers of the FER

1.7.6. Risk assessment

Verifiers:

a) FER technical report

b) Risk assessment

c) Risk mapping (fires, floods)

1.8. Ecologic protection of the site

1.8.1. Potential negative impacts arising from the restoration actions

Verifiers:

a) FER technical report

b) Impact assessment

c) Project budget

1.8.2. Biological control

Verifiers:

a) FER technical report

b) List of applicable legal regulations in force

c) Explanatory report supporting the need for its use

1.8.3. Use of synthetic chemicals

Verifiers:

a) FER technical report

b) Official Register of Phytosanitary Products

c) Explanatory report supporting the need to use synthetic chemicals

1.8.4. Emergency protocols

Verifiers:

a) Emergency protocols

b) Interviews with personnel in charge of occupational risk prevention

1.8.5. Use of exotic species

Verifiers:

a) FER technical report

b) Explanatory report supporting the need to use exotic species

1.8.6. Genetically modified organisms

Verifiers:

a) FER technical report

1.8.7. Aftercare and ongoing management

Verifiers:

a) FER technical report

b) Aftercare and ongoing management plan

c) Project schedule

d) Project budgets

1.8.8. Monitoring and evaluation

Verifiers:

a) FER technical report

b) Follow-up and evaluation plan

c) Project schedule

d) Project budgets

1.8.9. Information management

Verifiers:

a) FER technical report

b) Stakeholder participation and communication plan

c) Public participation report

d) Records, minutes, documents and other materials as evidence of the participatory process (newsletters, disclosure materials, websites, etc.)

1.8.10. Reports

Verifiers:

a) Dossier including all relevant information (according to 1.12.1)

2. *Implementation*

2.1. Ecological protection of the site

2.1.1. Potential negative impacts

Verifiers:

a) FER technical report

b) Field inspection to verify the absence of environmental and social impacts and, where appropriate, the measures carried out to prevent, mitigate and remedy them

c) Project implementation document

2.1.2. Chemical and biological control documentation

Verifiers:

a) FER technical report

b) Official Register of Phytosanitary Products. Authorisation of the relevant authorities

c) Work implementation document

d) Records on the application of chemical products and biological control agents used, including at least: purchase delivery notes, date of application, type of product, purpose, exact application site, dosage, application method and justification

e) Field inspection

f) Monitoring reports on the effects of their application (e.g. positive effects of the treatment, off-target damage)

2.2. Hiring of suitable personnel

2.2.1. Personnel involved in the FER project

Verifiers:

a) FER technical report

b) Technical accreditation documents of the person in charge appointed by the lead organisation of the FER project (appointment of the site manager; qualification or certificate of membership issued; etc.)

c) Accreditation documents of the project managers (CV, qualifications, training certificates)

d) Contractor's profile, company classification

e)Credentials of the implementing company

f) CV of the implementing company

g) Documents accrediting the legal status of the implementing company (articles of incorporation, bylaws, commercial register, etc.)

h) ISO standards certificates

i) SER CERP certificates

j) Contracts, agreements or arrangements with project managers

k) Interviews with project staff

l) Attendance reports

n) Environmental agency reports

o) Contracts

p) Organisational charts, minutes of appointment of those in charge, CVs of personnel, accredited training (diplomas, certificates), chainsaw operator's and machine operator's licences, etc.

q) Project implementation document

2.2.2. Recruitment options and requirements

Verifiers:

a) Worker surveys

b) Repository of companies participating in the implementation of the project and local implementation

c) Recruitment policies, job offers, contracts

d) Surveys of the local population, local contractors and local suppliers

2.3. Specifications of Machinery and Materials

2.3.1. Specifications

Verifiers:

a) FER technical report

b) Project implementation document providing evidence that the material resources comply with the requirements defined in the FER technical report

c) CE marking of the vehicles, technical data sheets

2.3.2. Regulatory requirements, delivery and handling of plant material

Verifiers:

a) FER technical report

b) Applicable legal regulations in force

c) Certifications, receipts or delivery notes of seeds and/or nurseries. Purchase propagating material documents

d) Phytosanitary passport

e) Quality control

f) Traceability of plant material

g) Field inspection

h) Project implementation document certifying having received the propagating material

2.4. Compliance with planning and design

2.4.1. Contracts, agreements and conditions

Verifiers:

a) Works plan

b) Project implementation document

c) Site visit reports

d) Reports by environmental agents

e) Partial and final completion certificates

f) Interviews with workers to verify how the control of the work is carried out

2.4.2. Preliminary documentation

Verifiers:

a) Site layout verification documentation

b) Works plan

c) Project schedule

d) Health and safety plan

e) Project implementation document

f) Document or report on actions

2.4.3. Quality control

Verifiers:

a) Technical specifications

b) Project implementation document

c) Partial and final completion certificates

d) Document or report on actions

2.4.4. Modifications

Verifiers:

a) FER technical report

b) Project implementation document

c) Changes to contracts and agreements

d) Changes to the FER technical report

e) Environmental agency reports

f) Document or report on actions

g) Record of consultations with key stakeholders

h) Field inspection

2.5. Compliance with environmental, labour and health and safety regulations

2.5.1. Compliance with environmental laws and regulations

Verifiers:

a) Applicable legal regulations in force (Annex 3)

b) Absence of evidence of non-compliance

c) Field inspections

d) Interviews with stakeholders

2.5.2. Contract

Verifier:

a) Legal agreement in force for commissioning, tender, contract, depending on the work

2.5.3. Compliance with labour regulations

Verifiers:

a) Contracts, payslips, and Social Security registration documents (TC1, TC2)

b) Interviews with workers

c) Interviews with trade union representatives

d) Requests for information from stakeholders

e) Visits to ongoing workplaces

f) Company collective bargaining agreements

g) Work councils

h) Labour certification audits

2.5.4. Compliance with health and safety regulations

Verifiers:

a) Basic Health and Safety Plan

b) Occupational risk prevention plan

c) Certificates signed by the workers (acknowledging receipt of personal protection equipment, proper training, etc.)

d) Interviews with workers or the health and safety coordinator, or other persons in charge who can verify compliance with health and safety regulations

e) Proof of having joined the company

f) Inspection of safety/security elements

g) Insurance policies (civil liability, accidents)

h) Visit to ongoing workplaces

i) Reports the health and safety coordinator or other responsible persons

2.5.5. Compliance with regulations governing volunteers

Verifiers:

a) Applicable legal regulations in force (insurance, training, etc.)

b) Volunteer agreements

c) Interviews with volunteers

d) Visits during activities involving volunteers

e) Training plans for volunteers

2.6. Communication with key stakeholders

2.6.1. Compliance with regulations on information and public participation

Verifiers:

a) Applicable legal regulations in force

b) Communication and stakeholder participation plan

c) Public participation report

d) Record of consultations with key stakeholders

e) Interviews with key stakeholders

2.6.2. Consultation Period

Verifiers:

a) Communication and stakeholder participation plan

b) Public participation report

c) Public inquiry/consultation record with key stakeholders

d) Key stakeholder interviews

2.6.3. Documentation

Verifiers:

a) Project implementation document

b) Document or report on actions

c) Site layout verification documentation

d) Partial and final completion certificates

3. *Monitoring, evaluation, aftercare and ongoing management*

3.1. Monitoring in an adaptive management framework

3.1.1. Measurement of indicators

Verifiers:

a) FER technical report

b) Monitoring and evaluation plan

c) Partial and final completion certificates

d) Project implementation document

e) Document or report on actions

3.1.2. Control and test plots

Verifiers:

a) FER technical report

b) Monitoring and evaluation plan

c) Project drawings

d) Project implementation document

e) Document or report on actions

3.1.3. Monitoring results

Verifiers:

a) Monitoring and evaluation plan

b) Document or report on actions

c) The 5-star system and ecological recovery wheels

3.1.4. Documentation file

Verifiers:

a) Document or report on actions

b) Storage and accessibility of results through digital media and data repositories

3.1.4. Communication of results

Verifiers:

a) Communication and stakeholder participation plan

b) Public participation report

c) Record of consultations, training activities, etc., with key stakeholders

d) Interviews with key stakeholders

e) Dissemination of results through digital media, social media and others

3.1.5. Monitoring personnel

Verifiers:

a) FER Project Report

b) Monitoring and evaluation plan

c) Interviews with stakeholders involved in this phase

3.2. Aftercare and ongoing management

3.2.1. Development of aftercare and ongoing management

Verifiers:

a) FER technical report

b) Aftercare and ongoing management plan

c) Project implementation document

d) Field inspection

e) Partial and final completion certificates

f) Document or report on actions

g) Interviews with workers

h) Higher-rank plans for land management

3.2.2. Financial commitment

Verifiers:

a) Project budgets

b) Financial guarantees (grants, committed resources, etc.)

c) Commitment letter signed by the lead managers of the FER

3.2.3. Updates

Verifiers:

a) FER technical report

b) Aftercare and ongoing management Plan

c) Monitoring and evaluation plan

3.2.4. Modifications

Verifiers:

a) FER technical report

b) Project implementation document

3.2.5. Aftercare and ongoing management personnel

Verifiers:

a) FER technical report

b) Aftercare and ongoing management plan

c) Monitoring and evaluation plan

ANNEX 2. CONTENT OF THE TECHNICAL DOCUMENT OF AN ECOLOGICAL RESTORATION PROJECT OF FOREST ECOSYSTEMS

The report of the FER project shall contain, according to its scale or intensity, these sections and headings on the planning and design of the FER project necessary for its implementation and evaluation. Information for this report will be based on various types of knowledge (according to Principle 2 of Gann *et al.*, 2019). It can be drawn from the experience of restoration practitioners, traditional ecological knowledge (TEK), local ecological knowledge (LEK) and scientific knowledge. Brief comments describe the content of sections and headings, describing the source of knowledge in each case.

1. INTRODUCTION

Background of the study area. It summarises the historical situations of the area to be restored, both legal and technical aspects.

Problem statement and justification. It justifies the need for restoration (legal, ecological, social, economic or a combination). It identifies and summarises the leading causes of degradation to which the area is subject.

Restoration goals and objectives. The goals and objectives of the restoration are listed, both ecological and social, including the expected level of recovery, the justification for which is detailed in later sections.

2. LEGAL STUDY

Current ownership and possession. Particular reference is given to groupings of estates of many owners.

Spatial extent. The spatial extent of the area to be restored, expressly indicating the area affected by the project in absolute and relative terms within this district.

Administrative situation. The legal jurisdictions of the proposed restoration area (municipal district, judicial district, land registry and other relevant information). Their status in the Catalogue of Public Utility Forestry, List of State Forestry or other registers of similar content is also mentioned. If there are areas in any of them, their boundaries, demarcations, approval orders, and dimensions will be stated.

Cadastral and registry information. Precise information is provided to identify the study area in the Cadastre and the Land Registry, as well as the assigned measurements in both registries, which will not always coincide with those obtained from recent topographic surveys or measurements of plane areas.

Past and future property developments. Property background and future plan. The report can also include information on ongoing cataloguing or consortium procedures for all or part of the area, propose more convenient legal solutions and foresee the most likely evolution of the property to adapt technical decisions accordingly. A reference to the administrative status of the land after restoration shall also be included if it planned to change.

Administrative boundaries and enclaves. The report briefly refers to the adjoining land from a legal viewpoint. Reference is also made to the number, size and ownership of sites in the study area excluded from restoration activities.

Liens and easements. Mention is made in the section on encumbrances for mortgages or temporary occupations. Special attention will be paid to rights of way (easements) and grazing rights to ensure they are respected by the restoration activity. The list of livestock trails in the study area can be included here. Other easements that need to be considered are those related to power or telephone lines which, depending on their height, condition restoration activities.

List of applicable legal regulations in force. Reference to the applicable regional, local and national provisions on territorial management.

List of territorial planning instruments Verification of the existence and summary of guidelines, if any, of approved spatial planning documents: Natural Resource Management Plans [*Planes de Ordenación de los Recursos Naturales* (PORN)], Master Plans for Use and Management [*Planes Rectores de Uso y Gestión* (PRUG)], Forest Resource Management Plans *(Planes de Ordenación de los Recursos Forestales* [PORF)], Forest Management Plans, Hydrological-Forestry Restoration Plans, Management Standards of the Natura 2000 Network Spaces, etc.

3. SOCIO-ECONOMIC CONTEXT

Delimitation of the region. Delimitation of the area in which the FER project is framed.

Structure of the region's population. Age pyramid population, activities and standard of living.

Employment. Seasonal and structural unemployment. The aim is to evaluate the possibility of hiring a workforce in the region for restoration work and its impact from a sociological viewpoint. At the same time, by studying what the population does for a living, the region's economic structure is also studied.

Industrial and tertiary sector development in the region. Particular reference to the processing industries of agricultural and extractive products.

Agricultural development of the region. Reference to areas and type of crops.

Livestock. Census information is compiled with species in the district, differentiating between stabled livestock and those that graze extensively, which also gives the grazing loads. Herding customs and routines are mentioned. The economic and sociological importance of livestock farming is valued. This leads to an assessment of over- or under-grazing loads to assess the effect of the reduction in surface area that the restoration may have.

Forest use. Brief description of the forests in the area to be restored with an absolute and relative evaluation of its biodiversity and the forest products obtained.

Communication network. The regional road network is described and assessed. Access to the area to be restored and the state of the internal road network is described in more detail, with an assessment of their adequacy.

Ecosystem services. Comparison of social demand and current and potential provision of ecosystem services.

4. IDENTIFICATION OF DISTINCT RESTORATION AREAS IN THE PROJECT

Most studies conducted during the ecological restoration planning stage aim to correctly identify the distinct restoration areas, one of the most important aspects of forest ecosystem restoration. Homogeneity is defined by biotic, abiotic, landscape, social, political, economic or cultural attributes. The delimitation of the study area may be based on administrative boundaries, which do not always coincide with natural boundaries, so the project area often has a relevant internal ecological heterogeneity from a restoration perspective.

For each distinct restoration area, different targets, objectives, approaches can be proposed, which will influence restoration techniques such as soil preparation and choice of species. Therefore, the correct definition of distinct restoration areas is indispensable for restoration planning.

Description of each distinct restoration area. Justification of the proposed division at different territorial scales, which should include a summary of the description of each stand in terms of the six key ecosystem attributes and social factors (e.g. historical, cultural, artistic).

Plan of distinct restoration areas. A stand plan is drawn up for further planning and guides the correct staking out of the enforcement.

Factors affecting natural recovery. Describe general soil characteristics, vegetation, erosion processes and other signs of soil degradation (e.g. salinization, compaction, acidification, contamination).

Key plant species are identified by characterising, for example, their population dynamics and resilience to past or future disturbances, evidence of sexual or vegetative regeneration, evidence of adequate growth (absence of malformations, growth rates according to site potential and FER objectives) and the absence of anomalous or massive mortality, among others. Animal species will be identified and characterised in terms of their population dynamics and resilience to past and future disturbances.

The FER technical report includes a forecast of the evolution of the ecosystem without intervention, including possible successional trajectories, considering the most likely scenarios and environmental and socio-economic certainty.

Prioritisation of areas of action. Areas for action are prioritised based on identification and zoning.

5. REGIONAL CONTEXT

Where necessary, this section shall be characterised for each distinct restoration area.

Geographical, geological, orographical and land use description of the region. Regarding the territorial area described for the socio-economic study, and at least the municipal area, these aspects should be described here: geographic, geological with mention of the historical geology and lithofacies, orographic with the relative situation regarding the major mountain systems, and reference to the succession of land uses in absolute and relative values expressed in terms of areas occupied by different activities and species. This section aims to give an idea of the context in which the study area is situated.

Degradation. It details the causes, intensity and extent of degradation and describes the effects on the physical environment in relation to the six key ecosystem attributes described in Gann *et al.*, 2019.

Physiography

Altimetry. Extreme, mean and weighted mean altitudes should be stated by the hypsographic curve. Divisions of the study area can be established, depending on the altitudinal differences and comparing them with the boundaries of the most important bioclimatic regions, which will be further reflected in the division into stands or zoning.

Slopes. In addition to the maximum, minimum and weighted average slope of the area to be restored, slope ranges shall be established according to the limitations of applying mechanical means in restoration actions to draw up a slope map where each interval will be plotted. This factor introduces a basic criterion for dividing the territory into stands.

Exposure. The exposure can also be reflected in a plan, representing shady, sunny and intermediate areas or areas with no defined exposure.

Division into distinct restoration areas according to physiography. Before the definitive division into stands of restoration and as an aid for the climatological and edaphic description of the study area, in cases of complex physiography, a synthesis of the physiographic factors is made at this point so the area to be restored is divided into physiographically distinct restoration areas.

Climate

Election of observatories. Meteorological observatories are chosen from the national network that best reflect their climate. Depending on their altitude, the required altitudinal corrections can be made.

Data overview. The basic thermometric and rainfall data characterising the area are presented in mean and extreme values, with or without altitudinal corrections.

Phytoclimatic classifications. Based on the above data, indices are calculated, and phytoclimatic graphs are constructed to assist subsequent decisions in restoration planning target setting (potential forest productivity indices and prediction of erosive states), choice of species (climatic homologation systems through phytoclimatic classifications); diagnoses of soil and vegetation degradation; determination of the right moment to carry out operations (planting, soil preparation) with climographs; and evaluation of the effect of soil preparation procedures (bioclimatic diagrams).

Climate scenarios. Climate scenarios within the restoration timeframe and their impacts on species distribution are analysed.

Soil science

Division into homogeneous soil areas. Considering the lithofacies, the division by physiography and the vegetation, the area under study is divided into areas with similar soil conditions. A forecast should be made for each soil property, including their potential evolution during restoration. If deemed necessary, proper sampling shall be conducted by digging pits.

Profile description. For each characteristic profile of an area, its physical, chemical and biological properties are assessed, checking which may limit: depth; stoniness; permeability; water retention capacity; fertility; possible dysfunctions due to active limestone, salinity or pH. In addition, horizons are identified, the profile is classified on a genetic scale, and its evolution is assessed.

Soil functions. The soil functioning in each of the defined areas is diagnosed, and possible conditioning factors of the distribution of species and habitats are identified, especially those that may affect the objectives of the FER project and the restoration techniques employed.

Hydrology

Hydrographic network. Description, designation and decimal classification of the watercourses draining the study area regarding significant watercourses to which they are tributaries. In complex situations, descriptive mapping is recommended.

Erosive states. Qualitative description of erosion phenomena within the study area. Specific degradation quantification using the USLE model (*Universal Soil Loss Equation)* or similar, either for the whole study area if it is homogeneous or for areas of different conditions. It may be helpful to make several calculation assumptions: in the current state, to decide on the preferred objective of restoration and by applying the tree protection factor to predict the effect of the proposed actions.

Influence of the erosive state of the project area on the exterior. The influence of the erosive state of the project area on the exterior is assessed. Models like USLE or similar can be applied, and the effect of the drained solid flows can be evaluated according to populations, civil works, agriculture, reservoirs, etc., outside the area to be restored and the frequency and intensity of floods caused by floods.

6. BIOTIC COMMUNITY

Where necessary, this section shall be characterised for each distinct restoration area.

Flora and vegetation. A floristic inventory of the study area is conducted to divide it into floristically homogeneous areas. A description of formations and phytosociology is made for each, and their significance, rarity, uniqueness and state of degradation are assessed. Descriptions of shrub formations express the thickness and height of the shrub formations. Plant species or plant communities protected in Spain and Europe and invasive exotic species in the study area or the region are described. Forecasts of vegetation evolution under different activity or climate change scenarios will be made.

Fauna. An inventory is made of the fauna (including invasive exotic species) in the study area and nearby areas. Essential information on migrations, breeding seasons and feeding is described. Reference is made to density, uniqueness and rarity. This is to assess responses to degradation pressures and the influence of restoration on fauna and vice versa. The habitat needs of the focal animals are assessed, including minimum ranges. In more detail, the study is systematised under these three headings: species protected in Spain and Europe, game species, and species that can cause damage during restoration processes.

Functional attributes. Functional ecosystem attributes, including nutrient cycles, characteristic disturbance and flow regimes, successional trajectories, plant-animal interactions, exchanges between ecosystems and any dependence on the disturbance of component species, are identified.

Degradation. It details the causes, intensity and extent of degradation and describes the effects on the biotic community and functions of the ecosystem regarding the six key ecosystem attributes described in Gann *et al.*, 2019.

7. ECOLOGICAL CONNECTIVITY

The report diagnoses the territory at a landscape scale, assessing the opportunities for the FER project to improve connectivity with the environment. It identifies ways to improve connectivity between habitats in the study area and enhance beneficial external ecological exchanges with other native ecosystems, to improve landscape-scale flows and processes, including colonisation and gene flow between sites. Specify strategies to ensure continuity of future management to align and integrate the project with the management of nearby native ecosystems and productive landscapes are included.

8. POTENTIAL RISKS AND DISTURBANCES

Comprehensive risk assessment to identify a risk management strategy for the project, including, in particular, contingency arrangements for unexpected changes in environmental, funding or human resource conditions. In this section, the increase in disturbances due to climate change should be considered.

Plant health. Description of stressors (i.e. pests and diseases) and vertebrate herbivores with direct influence on plants and their survival during the restoration, which could affect the current vegetation and potentially be introduced.

Causes, danger and frequency of forest fires. Review of the incidence of forest fires in the last five years in the region, with an indication of causes, areas broken down by plant formations and species, danger indices and means of prevention and extinction.

Droughts, winds, snowfall and other catastrophic weather events. Report on the frequency, intensity and damage caused by these regional phenomena.

Flood risks. In areas related to watercourses, indicate flood forecasts based on actual events and modelled forecasts.

Financing, human resources and other social risks. Procedures for unexpected changes in social factors, funding or human resources are implemented.

9. BACKGROUND STUDY ON RESTORATION IN THE REGION AND PROPOSAL OF A REFERENCE ECOSYSTEM

Literature study. An annotated summary of published references describing similar restoration projects or similar restoration techniques in the region.

Analysis of similar restorations. If there are ecological restoration projects or programmes in nearby areas, conduct a field study to verify their results and effects. It makes sense to imitate what worked well, identify possible failures and analyse their causes to avoid them.

Characterisation of reference ecosystems. Describe appropriate reference ecosystems or models for the native ecosystems to be restored using multiple indicators of the six key ecosystem attributes (Gann *et al.*, 2019). This information is optimally compiled from an appropriate number of reference sites and multiple sources of information, including (a) historical records and databases (e.g. watershed survey reports, regional planning projects, flora and fauna inventories); (b) maps of land use change over time; (c) other historical references. Sometimes, descriptions of intact ecosystems may be available from previous assessments, modelling or government guidelines. Reference sites should be environmentally and ecologically similar to the project site but have -at best- experienced little or minimal degradation or have undergone some degree of ecological recovery after degradation. SER tools like the decision tree (Gann *et al.*, 2019) can help identify appropriate reference models to inform project objectives. Especially in the most anthropized environments, reference models must consider socio-economic and cultural criteria and the role of populations in maintaining restored areas, particularly in environments affected by rural abandonment.

Reference ecosystems can be defined based on the predicted distribution of species and habitats derived from climate scenarios discussed in previous sections.

10. RESTORATION PLANNING

Restoration planning should include an overview and restoration goals and objectives. This planning is carried out for each of the distinct restoration areas. The implementation design should aim for the highest possible level of recovery.

Goals and objectives. Identify the goals and objectives of the FER project based on the assessment, knowledge of other restoration projects, properties of the reference ecosystem and social needs and priorities. Ecological and social objectives include the expected level of ecological recovery (i.e. the desired condition or state of ecosystem attributes). Full recovery is defined as the state or condition in which, after restoration, all key attributes of the ecosystem closely resemble those of the reference ecosystem. "Partial recovery" is where lower recovery levels are planned or occur due to resource, technical, environmental or social constraints. In cases of full recovery, the expected level will be aligned with the reference ecosystem, while in cases of partial recovery, it will include elements that deviate from the reference to some extent. Ecological objectives should quantify, where possible, the extent of the reference ecosystem attributes to be achieved. Social goals should be explicit and realistic, considering the area's timeframe and social capital.

Restoration approaches Describe restoration approaches for each distinct restoration area as described in Gann *et al.*, 2019 (e.g. natural regeneration, assisted regeneration, construction, combination) and identify opportunities to support natural recovery processes.

Analysis of alternatives Alternative restoration treatments are considered depending on the assessment, objectives and budget of the project. Whenever possible, alternatives are based on experimental plots and published scientific literature.

Restoration treatment prescriptions. The planning includes clear technical prescriptions of treatments for each distinct area of restoration, describing what, where and by whom the treatments are performed, and their order or priority. Where knowledge or experience is lacking, adaptive management or targeted research will be needed to inform appropriate prescriptions. If there is uncertainty, the precautionary principle should be applied in a way that reduces environmental risk. The planning identifies and justifies specific restoration approaches, describes specific treatments for each restoration area, and prioritises actions.

All treatments are carried out in a manner sensitive to natural processes that encourage and protect the potential for natural and assisted recovery. Primary treatments, including substrate and hydrological changes, animal and plant pest control, application of specific recovery activities and biotic reintroductions, are appropriately followed by secondary treatments as necessary. Because the recovery period can be long (e.g. growth of riparian vegetation), interim treatments should be planned and implemented to reduce adverse effects (e.g. nutrient and sediment influx into streams). Appropriate aftercare is provided for any plantation or animal group. Wherever possible, sustainable materials and processes are incorporated into restoration projects.

*Treatment of pre-existing vegetation***.** Need for treatment and its objective. Description of treatments (procedures). Intensity. Tools, equipment and implements. Operational process. Yield.

Preparation of the ground. Goals of the preparation. Preparation procedure Intensity. Tools, equipment and implements. Operational process. Yield.

Identification of possible compatible species and final choice. Seasonal and biotic community compatibility check. Among the species selected as compatible, the final choice is made based on the preferred target. It is decided here whether it is a mixed introduction in a foot-by-foot mixture or a monospecific restoration. Suitable ecotypes or provenances are determined for each species.

Forest reproductive material (FRM) and provenance. Type of plant: a choice is made between a bare-root plant and a plant in a container, and their external quality and morphology criteria. The most appropriate provenance for restoring the area is chosen based on current best practices (Gann *et al.*, 2019). The most appropriate FRM

category for the restoration objectives will also be defined. For regulated species, the requirements for plant quality, origin and FRM category must be according to the rules for their sale and distribution. The organisation of harvesting, packaging, transport and care of the FRM in the restoration area should also be established. Origin, quantity and characteristics of the seed. Seed treatments. Sowing rate.

Initial introduction density. Initial introduction densities are proposed and justified considering the future evolution of the introduced vegetation, its functions and treatability.

Repopulation method. Once the species to be introduced and the characteristics of the stand are known, the restoration method is defined: sowing or planting. There may be cases of different methods for different species.

Planting procedure. Tools, equipment and implements. Operational process. Yield. In addition, the time limits of the planting season and the conditions for planting days are laid down.

Sowing procedure. Tools, equipment and implements. Operational process. Yield. In addition, the time limits of the sowing season and the conditions for sowing days are laid down.

Statement that GMOs are not used. Verification that no genetically modified organisms have been or will be used in the FER project.

Hydrological restoration. If the number or importance of the hydrological works is high, a separate project is drawn up.

Spatial and temporal planning. (a) Timeframe, duration and justification. Action schedule. (b) Planning diagrams (GANTT, PERT, among others). (c) Maps showing distinct restoration areas to facilitate laying out. (d) Technical reference conditions. (e) Summary of human, material and mechanical resources to be used.

Implementation control methods. This refers to measuring the work carried out, quality control of materials and the implementation of the project and the setting out of contrast plots to control the work and how to make an inventory.

11. IMPLEMENTATION OF THE RESTORATION ACTIONS

Protection of the site from damage. Where necessary, partial or transient impacts, including social impacts, related to the restoration process are justified. Justify the use of mechanical equipment.

Involve appropriate participants. Treatments are interpreted and carried out responsibly, effectively and efficiently by, or under the supervision of, suitably qualified, specialised and experienced persons. Whenever possible, stakeholders, including the local population, are invited to participate in the implementation of the project.

Respond to changes. Adaptive management is applied based on the monitoring results. This includes corrective direction changes to adapt to unexpected ecosystem responses and additional work as needed. Sometimes, additional or new research may be needed to overcome particular impediments to restoration or performance monitoring systems, such as control plots, may need to be implemented at this stage.

12. AFTERCARE AND ONGOING MANAGEMENT

Aftercare and ongoing management plan. The FER managers are also responsible for ongoing management to avoid harmful impacts and post-project monitoring to prevent regression to a degraded state. This requirement should be considered in pre-restoration budgets. Comparison with the defined reference ecosystem should be continuous. Short-, medium- and long-term needs are described.

Need for aftercare and ongoing management. Aftercare refers to actions carried out while restoration and recovery are in progress. Ongoing management in this context refers to actions after the completion of ecological restoration (beyond 5 years) until the restoration goals and objectives have been achieved.

Replenishment. The minimum percentages for replenishment, its operational process, and the evaluation and control method are indicated.

Other care. Depending on the needs of each case, this heading includes the second tiling of the soil before seeding, weeding, pruning, grafting or installing a protective cover. In each case, it refers to the implementation method and the required tools, equipment and implements, the operational process, the performance and the implementation time. The use of livestock or other techniques for maintenance of the restored area (e.g. use of livestock for maintenance of firebreak areas) is also included in this section.

Involve appropriate participants. Stakeholders, including the local population, are invited to participate in this project phase whenever possible.

13. MONITORING AND EVALUATION PLAN

Contents of the Plan. The monitoring and evaluation plan complies with the recommendations of SER's International Standards. It is based on indicators linked to established goals and targets and incorporates a reference ecosystem or model. It is recommended that the Plan incorporate the six key ecosystem attributes, the five-star system, the ecological recovery wheel and the social benefits wheel from the SER Standards. The project should aim to achieve the highest possible level of recovery, considering ecological and social constraints. FER managers can achieve this by adopting a policy of continuous improvement informed by sound control.

Monitoring methods. Monitoring methods must be appropriate to the objectives of the project. Wherever possible, they should be user-friendly and carried out through participatory processes. Where formal quantitative sampling is required, the sampling design should include a large sample size to allow for statistical analysis and inference. Methods should always be sufficiently detailed to be repeatable in future years.

Schedule of monitoring activities. Schedule of monitoring activities, including monitoring indicators, linked to implementing restoration and adaptive management.

Opportunities for stakeholder engagement and learning. Monitoring is essential to determine whether objectives are being met and to provide learning opportunities. Whenever possible, stakeholders, including the local population, are invited to participate in this phase of the project, for example, through citizen science activities. Involving stakeholders in project design and data collection and analysis helps improve collaborative decision-making, provides a sense of ownership and commitment, motivates stakeholders to sustain engagement over the long term, and strengthens the capacity and empowerment of stakeholders. Any monitoring system must provide integrated opportunities for learning and adaptation.

Documents. Protocols are established for the long-term storage of all project-related information in an accessible form, including documents related to planning, implementation, monitoring and reporting, open access, secure storage and metadata considerations.

Report. Describe the monitoring methods and results and include an assessment of the data for evaluation, including progress towards ecological and social objectives and the reference ecosystem. Reports should convey information in an accurate and accessible manner, personalised for the audience, and specify the level and details of monitoring on which any evaluation of progress has been based.

Adaptive management measurements. Monitoring and evaluation results identify when restoration actions need to be adjusted. A system for recommending, approving and implementing specific adaptive management measures is described.

Network of experimental plots. The aim is to test the evolution of no-action areas, compare alternative techniques and rigorously evaluate the results and effects of restoration over time as a basis for adaptive project management.

14. SUPPLEMENTARY WORK PLAN

Wildlife protection. Appropriate means of protection are described, if necessary, depending on the type of restoration and the expected duration, as well as other measures to protect wildlife in the early stages of restoration.

Road network. Any necessary additions to the existing road network are defined, indicating lengths, construction characteristics and classification according to road surface and width. The construction of major roads due to their length, width or difficulty of construction will be the subject to a separate project with its own environmental impact evaluation study.

Forest fire prevention and extinguishing infrastructures. Prevention, surveillance, extinguishing.

15. ENVIRONMENTAL IMPACT ASSESSMENT

Applicable legal regulations (according to Annex 3).

Qualitative impact assessment. The projected activities are described in terms of their effect on the environmental, cultural, economic and social factors, qualifying the positive, negative or neutral impacts and referring to their temporal evolution and outcome.

Preventive and corrective measures to be implemented to reduce or eliminate the adverse environmental effects of each restoration alternative on the environment.

Environmental monitoring and follow-up programmes for the project. A programme is established to control and guarantee compliance with all the preventive, corrective and compensatory measures specified in the environmental impact study.

Final assessment of the environmental impact study. Summary of the study and the conclusions reached on the feasibility of the proposed actions, the analysis and evaluation of the existing alternatives and the proposal of the corrective, preventive measures and the monitoring programme considered appropriate.

16. BASIC HEALTH AND SAFETY STUDY

Applicable legal regulations (according to Annex 3).

Health and safety rules applicable to the FER project.

Identification of the occupational hazards that can be avoided, indicating the technical measures necessary to avoid them.

List of occupational hazards that cannot be eliminated, specifying the preventive measures and technical safeguards intended to control and reduce such hazards and assessing their effectiveness.

Specific measures relating to work with special hazards.

ANNEX 3. SPANISH LEGISLATION REFERENCE

This annex compiles the main legislation applicable at a national level in Spain as of March 2023. This is not an exhaustive list, and it should be noted that the regulatory framework is updated relatively frequently. This list can be completed with:

FSC, 2018 (Annex A). Current national legislation of reference for: legal rights, protection of environmental values, chemical and phytosanitary substances, water, safety and health, technical specifications of machinery, work and ecosystem services, among others.

Mola et al., 2018 (Annex 1). Regulatory framework for the application of ecological restoration in Spain.

Valladares et al., 2017 (Annex 6). Current national reference legislation for climate change mitigation and adaptation.

Comisión Europea, DG de Medio Ambiente. (2022). Propuesta de Ley del Parlamento Europeo y el Consejo sobre la restauración de la naturaleza.

Resolución de 20 de enero de 2023, de la Subsecretaría, por la que se publica el Convenio entre el Ministerio de Educación y Formación Profesional y el Organismo Autónomo Parques Nacionales, para la promoción y el desarrollo de actividades relacionadas con la educación para el desarrollo sostenible y la ciudadanía mundial.

Orden PCM/1341/2022, de 29 de diciembre, por la que se publica el Acuerdo del Consejo de Ministros de 20 de diciembre de 2022, por el que se aprueba la Estrategia de Biodiversidad y Ciencia (2023-2027).

Resolución de 27 de diciembre de 2022, de la Secretaría de Estado de Medio Ambiente, por la que se publica el Acuerdo del Consejo de Ministros de aprobación de la revisión de la Estrategia Forestal Española horizonte 2050.

Resolución de 27 de diciembre de 2022, de la Secretaría de Estado de Medio Ambiente, por la que se publica el Acuerdo del Consejo de Ministros de aprobación de la revisión del Plan Forestal Español 2022-2032.

Real Decreto 1057/2022, de 27 de diciembre, por el que se aprueba el Plan estratégico estatal del patrimonio natural y de la biodiversidad a 2030, en aplicación de la Ley 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad.

Real Decreto-ley 15/2022, de 1 de agosto, por el que se adoptan medidas urgentes en materia de incendios forestales.

Orden TED/132/2022, de 21 de febrero, por la que se adopta el Primer Programa de Trabajo del Plan Nacional de Adaptación al Cambio Climático 2021-2030. Boletín Oficial del Estado, 28-02-2022, 50, 23733-23734.

Real Decreto 1054/2021, de 30 de noviembre, por el que se establecen y regulan el Registro de operadores profesionales de vegetales, las medidas a cumplir por los operadores profesionales autorizados a expedir pasaportes fitosanitarios y las obligaciones de los operadores profesionales de material vegetal de reproducción, y se modifican diversos reales decretos en materia de agricultura.

Orden PCM/735/2021, de 9 de julio, por la que se aprueba la Estrategia Nacional de Infraestructura Verde y de la Conectividad y Restauración Ecológicas. Boletín Oficial del Estado, 13-07-2021, 166, 83217- 83470.

Ley 7/2021, de 20 de mayo, de cambio climático y transición energética (BOE, núm. 121, de 21/05/2021) (BOE, núm. 299, de 14/12/2007).

Resolución de 29 de abril de 2021, de la Subsecretaría, por la que se publica el Acuerdo del Consejo de Ministros de 27 de abril de 2021, por el que aprueba el Plan de Recuperación, Transformación y Resiliencia.

Ley 9/2018, de 5 de diciembre, por la que se modifica la Ley 21/2013, de 9 de diciembre, de evaluación ambiental, la Ley 21/2015, de 20 de julio, por la que se modifica la Ley 43/2003, de 21 de noviembre, de Montes y la Ley 1/2005, de 9 de marzo, por la que se regula el régimen del comercio de derechos de emisión de gases de efecto invernadero

Real Decreto 124/2017, de 24 de febrero, relativo al acceso a los recursos genéticos procedentes de taxones silvestres y al control de la utilización. Boletín Oficial del Estado, 14-03-2017, 62, 18478-18499. BOE-A- 2017-2743.

Ley 45/2015, de 14 de octubre, de Voluntariado.

Ley 21/2013, de 9 de diciembre, de evaluación ambiental. Boletín Oficial del Estado, 11-12-2013, 296. BOE-A-2013-12913.

Real Decreto 630/2013, de 2 de agosto, por el que se regula el Catálogo español de especies exóticas invasoras.

Real Decreto 1220/2011, de 5 de septiembre, por el que se modifica el Real Decreto 289/2003, de 7 de marzo, sobre comercialización de los materiales forestales de reproducción.

Real Decreto 556/2011, de 20 de abril, para el desarrollo del Inventario Español del Patrimonio Natural y la Biodiversidad. Boletín Oficial del Estado, 11-05-2011, 112, 29361-29398. BOE-A-2011-8228.

Orden ARM/2444/2008, de 12 de agosto, por la que se aprueba el Programa de Acción Nacional de Lucha contra la Desertificación en cumplimiento de la Convención de Naciones Unidas de Lucha contra la Desertificación.

Ley 37/2007, de 16 de noviembre, sobre reutilización de la información del sector público. Boletín Oficial del Estado, 17-11-2007, 276, 47160-47165. BOE-A-2007-19814.

Ley 27/2006, de 18 de julio, por la que se regulan los derechos de acceso a la información, de participación pública y de acceso a la justicia en materia de medio ambiente. Boletín Oficial del Estado, 19-07-2006, 171. BOE-A-2006-13010.

Ley 9/2006, de 28 de abril, sobre evaluación de los efectos de determinados planes y programas en el medio ambiente.

Ley 43/2003, de 21 de noviembre, de Montes. Boletín Oficial del Estado, 22-11-2003, 280, 41422-41442.

Real Decreto 289/2003, de 7 de marzo, sobre comercialización de los materiales forestales de reproducción.

Real Decreto 1997/1995, de 7 de diciembre, por el que se establecen medidas para contribuir a garantizar la biodiversidad mediante la conservación de los hábitats naturales y de la fauna y flora silvestres.

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