EUROPEAN FOREST FIRES NETWORK - EUFOFINET

Synthesis of good practice

GP5: Restoration of burned areas

INTRODUCTION

Leader: National Forests Office (ONF)
Donor Partners: ONF, NFC, FRI, NORTHUMBERLAND, CESEFOR
Recipient Partners: PEDA, TUSCANY, ONF, NORTH AEGEAN, AGASP, CESEFOR, THESSALY, EPIRUS

The definition selected for this topic when the project was launched is as follows:
"After the passage of fire, particularly in densely populated areas where public pressure is strong, the temptation is great to clear the traces of fire as quickly as possible, often requiring costly work. Here and there experience has shown that sometimes it may be wiser not to rush too much and to allow more time to think.
The good practice to be shared might be the use of a guide (on both policy and techniques) setting intervention priorities and practices to be implemented after the occurrence of fires."

This topic was the subject of a workshop in Valabre (France) from 16 to 20 May 2011. During the workshop, the five donor partners presented their practices in the meeting room, while a day of field visits in the Var and Alpes-de-Haute-Provence *départements* enabled the attendees to see how the measures were applied in different contexts and after varying periods of time. The information resulting from this workshop was usefully supplemented by an article provided afterwards by the Galician Public Safety Academy (AGASP).

Discussions between partners enabled them to compare the processes and measures that had been adapted to their specific contexts. This revealed many similarities which could be described in a general framework, identifying areas requiring consideration, priorities for action and a series of measures to be selected depending on the context. This is the common framework sought by the partners in the original definition.

The first section of this document provides a brief description of the information presented by the donor partners, highlighting the main elements, followed by the second section which summarises the general framework that can be used in any context. The conclusion highlights the key points and presents the information that was transferred to the recipient partners.

CURRENT SITUATION AMONG PARTNERS

Slovakia:

1,933,000 ha of which 2/3 is intended for production.
550 ha/year burned on average.
Average extent of fires: 1.5 ha (max 150 ha).

Law requiring all owners to reforest within 2 years.

Steps:
- Preliminary analysis that classifies sectors according to levels of damage to soil and vegetation, and the level of erosion risk.
- Proposal of specific measures for each sector (including remediation of damp soils, plant protection measures, etc.).
- Implementation of measures: preference for natural regeneration; if planting, choice of a composition of species appropriate to the site based on local sources, greater use of plants in containers to maximise the recovery rate and irregular, well-spaced positioning of plants to leave room for additional natural regeneration.
- Revision of the management plan (complete overhaul, change of objective or simple modification).

Main objectives: to restore as natural a stand structure as possible, to restore the ecological links and natural processes that ensure a return to a stable ecosystem capable of fulfilling all of a forest's roles (social, economic, environmental, landscape, soil protection).

Funding by the owners or public managers with the possibility of state aid.

Poland:

Primarily coniferous forests (*Pinus sylvestris*) and mainly intended for production.

Law requiring all owners to reforest within 5 years.

Steps:
- Preliminary analysis that distinguishes the levels of damage to stands (4 levels: no damage to trees, partial damage with the possibility of regeneration, severe damage with possibility of harvesting trees, severe damage without the possibility of harvesting).
- For the least affected stands, keeping trees and giving priority to natural regeneration, with possible use of artificial seeding (with appropriately-sourced seeds) depending on soil type or if there is an inadequate reserve of seeds in the soil, and progressive logging of remaining trees in the event of dieback.

- For the most affected stands, immediate logging of trees, with priority given to natural regeneration over the next 1 or 2 years, complemented by artificial seeding, then in the event of failure, planting with mycorrhizal plants.
- Possible use of organic fertilizers on poor soils to compensate for the loss of productivity.
- In the event of a large fire in a high fire-risk area, requirement to structure the restored area with a grid of 30-50m wide strips planted with broadleaved species.

Funding by the owners or public managers with state aid if the author of the fire has not been identified (which is often difficult).

Peak District National Park (UK):

Natural park of about 150,000 ha with an average of around ten fires/year, characterised by heathlands and peat bogs, which in the world cover about 1.5 million hectares.

The problem with fires in heathlands and bogs is that if the upper layer (acrotelm) is destroyed, the entire soil becomes extremely vulnerable to erosion, affecting its role in water storage, carbon storage and as a landscape.

One of the solutions has been a campaign to improve awareness and inter-department cooperation in order to anticipate restoration problems as early as the fire-fighting phase, trying to protect this layer as much as possible by stressing the importance of quenching to prevent destruction penetrating too deeply, especially of unburned patches in the middle of a burned sector, which were previously left to burn because there was no risk of them causing the fire to spread.

Unlike other contexts where it is preferable not to rush and to let nature take its course, a key factor to avoid irreversible damage is rapid response during and after the fire to stabilise the situation, curb erosion and revitalise vegetation as quickly as possible.

Measures implemented: aerial seeding of herbaceous plants, liming and fertilization to compensate for the soil's acidity, spreading heather brash to protect the bare soil, damming gullies to limit runoff, using geotextiles to stabilise the soil.

Funding by the state, the EU and various partners.

Castilla y León (Spain):

Five million hectares of forest, an average of 2000 fires/year and 26,000 ha burned/year.

Restoration covers the different roles of the forest: ecosystem reconstruction, regulation of runoff, erosion reduction, landscape, wildlife habitat, and, in the longer term, production (timber, resin, fruits, fungi) and CO_2 sequestration.

Steps:

- Inventory of affected areas (stand types, regeneration capacity, erosion risks, environmental issues, condition of equipment).
- Writing of a study.
- Writing of a report for the sites in the Natura2000 network.
- Administrative procedures.
- Implementing actions: extraction of wood to avoid the risk of disease, measures to reduce erosion, repair of equipment, soil preparation, reforestation through sowing or planting, protection against animals.
- Monitoring restored sites: regeneration inventory, clearing seedlings, managing health problems on retained trees, etc.

To ensure that plants are of good quality and appropriately sourced, creation of a seed bank and nursery.

Funding by the owners or public managers with the possibility of state aid.

Pontevedra, Galicia (Spain):

Problem of restoration after a succession of fires that burned 40,000 ha in August 2006, in very hilly areas.

Steps in 2 phases:

* Urgent measures to limit erosion (August-October 2006)

- Mapping of priorities (slopes >30% within 25 m of watercourses).
- Direct measures: creation of barriers and fascines (partly using willow stakes in the wettest areas, 50% of which took root), damming, mulching (with straw or burned wood chips), manual or hydraulic seeding of mixtures of local herbaceous plants and shrubs (effective if done as early as possible before the heavy rains of autumn and accompanied by mulching or fascines).
- Related measures: removal of the abundant waste found in the valleys, localised seeding of broadleaved and coniferous species (behind the fascines or in the mulched areas), encouraging biodiversity (keeping large trees and wood from dead broadleaved trees), measures to help wildlife (introduction of shelters, nesting boxes, feeders and drinking facilities).

* "Hydrological and forestry restoration" (as of December 2006)

Objective: to supplement plant cover and improve the infiltration capacity of soils.
- Treatment by watershed, identifying priorities and preferentially treating the upper parts of watersheds.
- Prior administrative management to resolve land ownership issues and gain permission from the various departments.

- Treatment of burned timber (keeping 5-10 trees/ha): windrows following contour lines, chipping, extraction for biomass energy.
- Ground preparation (subsoiling in lines or spot planting using a bulldozer or spider excavator).
- Planting: suitable species (maritime pine and broadleaved), locally sourced, container seedlings, relatively high density, from 1250 to 1666 plants/ha.
- Improvement of water infrastructure and prevention equipment (cuts, discontinuities).

Unusual source of funding: the regional forest administration conducted the study to set priorities for emergency work, and funded supervision, supplies and part of the manpower, but most of the major manpower needed to carry out the work very rapidly was provided by the municipalities and owners' associations.

Mediterranean Zone (France):

5.3 million ha of natural areas affected by about 2100 fires/year destroying about 14,700 ha/year.

The law requires municipalities to ensure public safety (through emergency work), but there is no obligation concerning reforestation or regeneration.

Steps:
- Simple, systematic and immediate analysis of all fires that have burned more than 50 ha, to determine the relevance of a study.
- Detailed study (inventory, public safety phase, rehabilitation phase).
- Implementation of emergency work (reopening access, ensuring safety by felling dangerous trees, preventing flooding by clearing valleys, building small dams in the valleys, creating fascines to stabilise soils, establishing retention ponds).
- Seeking funding for the rehabilitation phase and implementation of fundable work (coppicing broadleaved trees, helping with seeding of conifers, planting in areas lacking natural regeneration, specific rehabilitation work in environments with high ecological potential, redevelopment of areas of forest).

Funding for emergency work virtually guaranteed by the state and local authorities, funding of rehabilitation work harder to obtain and more varied (owners, local authorities, state/EU, sponsorship).

SYNTHESIS

The six cases presented above illustrate the responses applied to the various contexts (soils, vegetation, climate, fire regime) and primary objectives (production, protection, landscape). However they also highlight similar approaches from which a common general framework can be derived, which will be detailed in this synthesis. We have attempted to define a comprehensive framework that addresses the majority of cases encountered, and which could be used as a toolbox from which solutions can be drawn depending on the local context.

This framework is based on four basic steps:
- Preliminary analysis
- Emergency measures
- Rehabilitation measures
- Monitoring and feedback

1- Preliminary analysis

This first step is crucial, to clearly identify the priorities and to use the resources in the right place at the right time.
It should be conducted as soon as possible in order to define the emergency work to be carried out. However, pragmatically, measures to address obvious cases should be implemented immediately, without waiting for a study.

1.1 – Optional preliminary analysis
This almost immediate approach (a few days after the fire) can determine whether it is worthwhile pursuing this analysis, based on expert analysis of predefined maps using criteria such as:
- Slope gradients: to assess the risk of erosion (depending on soil type).
- Human and infrastructure issues: to assess post-fire risk in terms of civil safety.
- Type of vegetation before the fire: to assess both the need to restore the landscape (forest landscape or shrubs or grass only) and the natural regeneration capacity (broadleaved/coniferous).
- Environmental issues: to assess whether there are specific needs for environmental rehabilitation.
- Type of ownership: to assess land management problems and administrative difficulties.

This first approach, which can be systematised with the production of standard maps, is especially useful in high fire-risk areas, where it helps to focus studies and concentrate resources where they are most needed. It can be used as a decision support tool for policymakers and/or funding authorities to initiate more detailed studies.

It can be improved by adding other criteria (provided that the mapping can be pre-established on consistent bases) and by defining rules based on the quantification of these criteria (for example: if x% of the burned surface relates to slopes that are less than a given gradient, then a thorough erosion risk assessment study is unnecessary; caution is however needed to avoid over-systematising, because if the reasoning given in the example were applied too broadly, it could overlook an isolated valley leading into sensitive human interests and by itself justifying specific measures, even if the rest of the fire does not warrant an overall study).

1.2 – Detailed study

It often makes sense to divide this study into two phases: emergency measures to be implemented very quickly (a few weeks after the fire) and rehabilitation measures for which more time for consideration can be allowed (wherever possible, it is wise to wait until after the first growing season following the fire to better observe the state of natural regeneration).

It begins with a precise map inventory, based on field visits and/or digital data (satellite imagery, digital terrain models, etc.).

Important points of the inventory:
- Identification of post-fire civil safety issues: access routes to be re-established, risk of falling trees, destabilised stones or boulders, etc.
- Assessment of levels of damage to the forest, important data that will determine the treatment to be applied to burned timber and be used to assess regeneration and soil maintenance capacity, etc.
- Identification of the risks of erosion and torrential flooding. The opinion of experts on this subject may be useful, especially outside mountain regions, which are their usual area of expertise. Consideration of slope gradients, type of soil and bedrock, the drainage network, remaining plant cover, etc.
- Analysis of the human, environmental and landscape issues, etc.

The study should take into account the different roles of the forest. It would be preferable if this were carried out by a multidisciplinary team and involved the various players.
The study should define the intervention priorities (spatial and temporal), specify appropriate measures, analyse any implementation difficulties (technical, land-ownership, legal, etc.) and estimate the cost of the actions. It can also identify areas where there is no need to intervene, or where it would be wise to wait before continuing the debate. It must provide the tools to enable decisions to be made about what measures can actually be implemented with optimal use of the available resources.

2- Emergency measures

These should be implemented within the first few days or months after the fire (usually before the first heavy autumn rains, and at the latest before the rains of the following spring).

- Public safety measures: reopening access, repairing damaged structures, felling dangerous trees, installing nets for protection against rockfalls, prohibiting access, etc.
- Measures to control torrential flooding: cleaning of valleys, ditches and culverts to facilitate water flow, cleaning banks, felling and extracting burned timber to prevent jams, creating retention ponds and developing dams and mini-dams to reduce transport of materials (mud, stones, etc.).
- Soil maintenance measures: creation of fascines or barriers on steep slopes, mulching (straw, plant debris, burned wood chips) as a protection against the direct impact of rain and promote grass growth, manual or hydraulic seeding of mixtures of herbaceous plants and/or shrubs (reserved for certain areas where soil maintenance is a top priority, because it is costly and may also compete strongly with tree regeneration), use of geotextiles, etc.

3- Rehabilitation measures

Some must be carried out fairly quickly (and can even be implemented concomitantly with some emergency measures), while others are more long term.

- Treatment of burned timber: apart from the need for felling due to the emergency work mentioned above (felling dangerous trees, cleaning valleys, creating fascines and mulching with wood chips, etc.), felling may also be necessary for other reasons: landscaping (restoring sightlines), health (particularly for conifers, with the risk of bark beetle attack), facilitating subsequent mechanisation, and regeneration from broadleaved stump sprouts. Conversely, it may be decided not to fell all or part of the burned trees for various reasons: their role in providing shelter or shade, or in maintaining soil, keeping partly affected trees to serve as seed producers, keeping certain broadleaved species that sprout from the trunk (e.g. the cork oak *Quercus Suber),* keeping very old trees or patches of dead timber for ecological reasons, etc.

- Reforestation: natural regeneration is preferred, as many experiments have shown that nature's ability to take its course is often underestimated. However in some cases (lack of seed producers, seed stock in the soil destroyed, soil too shallow or eroded, production objective, preferred species, change in species) it can be complemented or supplemented by seeding or planting, with a choice of appropriate species and sources. In the case of planting, the site should be suitably prepared: subsoiling in lines (taking care to create discontinuities to avoid erosion problems), spot planting using a bulldozer or spider excavator on slopes that are too steep. There seems to be a consensus that plants in containers offer the best possible recovery rate.

- Support for recovered stands: in a seriously weakened and disrupted ecosystem, animal and plant pests will be even more virulent and this risk must also be taken into account by appropriate measures: health protection (monitoring and possible felling of any retained but weakened trees, trapping, chemical treatments), protection against wildlife (game, rodents, etc.) using fences or individual protection, control of invasive or concurrent vegetation (chemical treatments, manual or mechanical clearance).

- Preventive measures: starting from scratch on a destroyed area is an opportunity to create or relocate appropriate prevention facilities or infrastructure, in an attempt to make the area more resistant than before. Improvements in fire-fighting and surveillance could be achieved through better access, water points, lookouts, etc. Certain at-risk uses or activities could be redirected, moved or redefined. Where large areas are affected, the forests could also be partitioned by logging for fuel or introducing lower risk species (strips of well-spaced broadleaved species separating the conifer plots, for example).

- Environmental restoration measures: while certain measures complement the previously described measures taken for other purposes (maintaining soil, promoting natural regeneration, eliminating invasive species, keeping dead or very old trees, maintaining open areas, etc.), it is also possible to implement specific ecological engineering measures (restoring some wetlands, maintaining open areas, etc.) or measures to help wildlife (artificial shelters and nesting boxes, feeders and drinking facilities).

- Revision of the management plan to include the new context (changes to soils and stands) and new objectives (new production deadlines, managing the risk of erosion, plant health risks, redeployment of some activities, etc.).

4- Monitoring and feedback

All the actions undertaken must be continuously monitored, and assessed in the short and medium term. Data from this monitoring and assessment should be used as input for the debates to be held between each step. In particular, once the emergency measures have been carried out, it is important to evaluate the results before continuing with the rehabilitation measures. Similarly, when preparing to implement rehabilitation measures, if the initial choice has been made to favour natural regeneration, this must be monitored closely and the results will be used to decide whether this natural regeneration needs to be complemented or supplemented. Finally, an assessment conducted after all the measures have been implemented provides overall feedback on the entire operation.

The study can include monitoring arrangements from the start and schedule important milestones for a review or a new debate.

This monitoring should be documented as thoroughly as possible, through tables, reports, maps and photographs. The record of all this data will be used for feedback, training and sharing experience, and communication.

After allowing enough time to pass (which may be several years for the rehabilitation measures), it is important to obtain feedback. This enables the relevance and performance of the various measures implemented to be assessed after the fact. It is a very effective way of improving technicians' knowledge and skills, enriching training and sharing of experience, justifying decisions to be taken during new studies by helping to convince policymakers and funding authorities, and reporting on the results expected from the measures implemented.

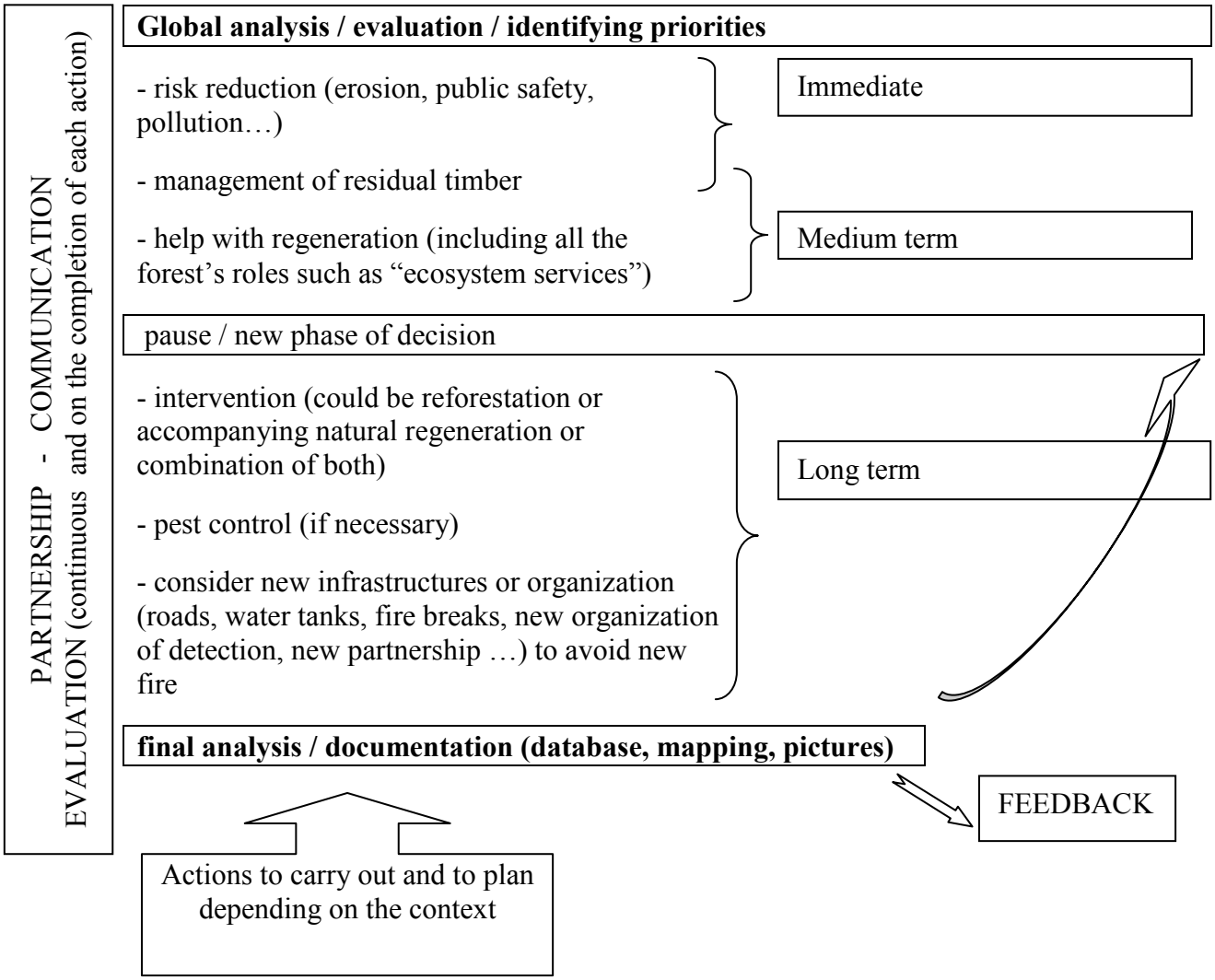
The entire process can usefully be accompanied by appropriate communication, which alerts the public about any post-fire risks, describes the measures taken and the results achieved, and justifies any non-intervention and the need for debate. This communication seeks to obtain the public's approval, support or even assistance.

The success of the restoration operation will be facilitated by the establishment of technical and financial partnerships throughout the process, from preparation of the study to monitoring and assessment, and including the implementation of actions. The specialised skills provided will ensure that the most appropriate techniques are selected, particularly in specific areas such as managing the risks of erosion, flooding, landslides, etc. or in environmental engineering. Financial partnerships will help ensure that the maximum number of measures are implemented, and will be publicised during the feedback and communication steps.

CONCLUSION

Key points:

The good practice identified resulted from the pooling of the various practices implemented by the partners. This summary reveals an overall process for restoration operations that can be summarised in the following diagram:



This ideal process includes a number of steps implemented to varying degrees by the different partners, by standardising them so they can be reproduced. The intervention techniques may vary depending on the environment (climate, natural and human), constraints, and any objectives set for the forest, but the common key points identified are applicable regardless of the context.

In particular, the three analysis phases (preliminary, intermediate after the short- and medium-term actions, final) are essential for implementing consistent and useful actions that do not squander resources, and that aim to return to a situation that is at least as good as before.

Phasing the types of action, closely linked to these analysis phases, makes it possible to focus on the important aspects at the right time, without rushing or overlooking anything.
Throughout this process, it is essential to combine the concepts of partnership (to allow consensus and synergy that help ensure the success of these actions), communication (to explain and gain approval for the phasing and the choice of these actions) and continuous assessment (to ensure the best possible success and prepare the next analyses and the feedback).

Finally, documentation and feedback are also important for improving technical proficiency and providing input for the different analysis phases, and can be very useful for training new experts.

Information transferred:

The ONF and the AGASP, despite their technical proficiency, identified a lack of standard procedures and will be developing technical guidelines based on this synthesis.

Tuscany will integrate some aspects of this summary in the next revision of its Operational Fire Prevention Plan: the assessment method used in the preliminary analysis, the criteria for prioritising and selecting techniques, measures that integrate environmental protection.

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