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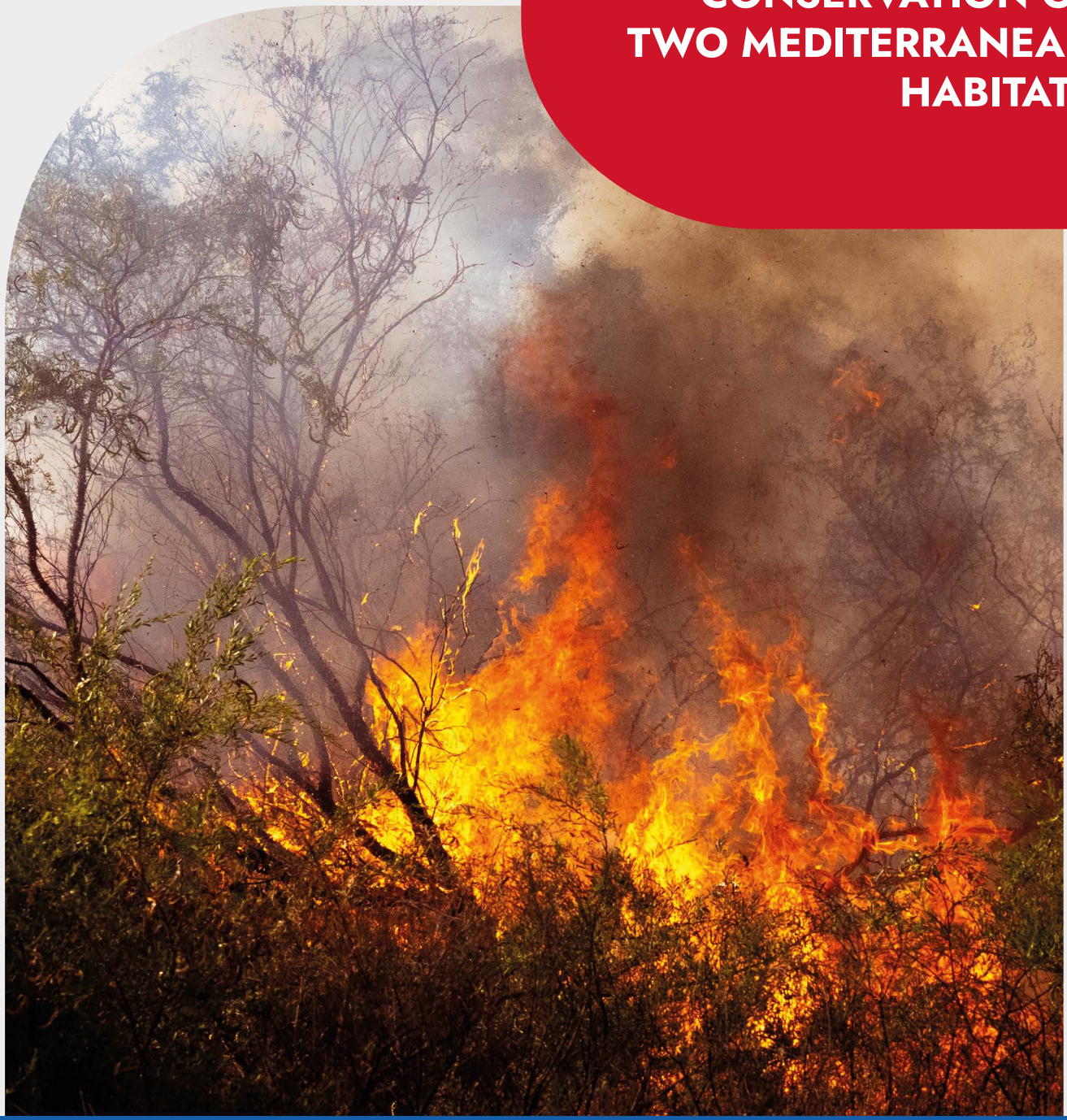
PROTOCOLS FOR WILDFIRE RISK REDUCTION TO SUPPORT THE CONSERVATION OF TWO MEDITERRANEAN HABITATS



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This publication is an outreach product derived from the activities of the LIFE GoProForMED Project, specifically from "Work Package 3 – Tools for Close-to-Nature Forest Management", within which a dedicated task was focused on identifying silvicultural interventions suitable for reducing wildfire risk and compatible with the conservation objectives of two target habitats.

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The contents of this publication are based on the methodological and technical-operational report (Deliverable D3.2) prepared by **DISAFA, University of Turin**, the partner responsible for this specific action.

Compagnia delle Foreste

Editorial coordination, text drafting, graphic design, and layout by **Compagnia delle Foreste**, the partner responsible for communication.

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PROTOCOLS FOR WILDFIRE RISK REDUCTION TO SUPPORT THE CONSERVATION OF TWO MEDITERRANEAN HABITATS

Within the framework of the LIFE GoProForMED Project, a specific action was designed to link Close-to-Nature silvicultural criteria and prescriptions aimed at conserving and enhancing biodiversity with wildfire prevention needs, which are crucial in such a critical context as the Mediterranean basin.

This publication aims to provide an overview of this action, focusing mainly on its operational aspects to support the work of forest managers and technicians.

For further details, please refer to the Methodological and Technical-Operational Report available on the official Project website:
www.lifegoproformed.eu/publications/protocols-wildfire-risk-reduction.html

THE MEDITERRANEAN CONTEXT

A unique laboratory for testing wildfire risk mitigation

The Mediterranean Basin hosts an **extraordinary richness of species and habitats** of community interest, making it one of the world's biodiversity hotspots.

Although it covers only 1.6% of the Earth's surface, the region contains 7-10% of the world's flora, with a high rate of endemism (60%), which increases its uniqueness and value.

However, this natural capital is exposed to **multiple natural and human-induced disturbances**, further aggravated by the climate crisis. Among the most critical of these are **wildfires**, which increasingly display extreme behavior due to climatic and socioeconomic drivers, posing serious threats to people, the environment, and the economy.

The widespread presence of the wildland-urban interface (WUI) and **highly flammable vegetation**, combined with the **abandonment of traditional rural practices**, further heighten the risk on a territorial scale.

This dual condition, being both a biodiversity hotspot and an epicenter of wildfire risk, makes the Mediterranean a unique laboratory for research and experimentation on innovative solutions.

A CHALLENGE FOR GoProForMED

Wildfire prevention and biodiversity conservation

The LIFE GoProForMED Project proposes an integrated approach that combines habitat-specific silvicultural prescriptions with wildfire risk reduction measures.
The adopted methodology allows for the assessment of potential conflicts between different management goals, the enhancement of ecosystem resilience, and the reduction of risks to people, habitats, and infrastructure.
The analysis was conducted at two levels:

- **landscape scale,** to assess the effects of the strategic spatial arrangement of interventions;
- **stand scale, t**o evaluate the impact of Close-to-Nature silvicultural prescriptions on fire behavior within the target habitats.

For this purpose, two representative sites were selected, each containing one of the project's target habitats:

- the SIC **Pascoli montani e cespuglieti del Pratomagno** (IT51180011, Italy), featuring chestnut forests (Habitat 9260),
- the SIC **Muntanyes de Prades** (ES5140008, Spain), featuring black pine forests (Habitat 9530*).

9260 *Castanea sativa* woods

9530* (Sub-)Mediterranean pine forests with endemic black pines

LANDSCAPE SCALE: IDENTIFYING PRIORITIES

Landscape-scale analysis is essential to understanding wildfire ignition, propagation, and interaction with the territorial matrix. It is based on **assessing wildfire hazard** through **Decision Support Systems** (DSS) capable of identifying, at landscape level, **the most probable fire behavior** (i.e., potential fireline intensity, flame length, and fire rate of spread) under **synoptic weather conditions favorable to fire occurrence.**

Given a **fixed percentage of the total flammable area** to be treated, it is necessary to find the **optimal solution** to effectively protect populations in wildland-urban interface areas, key ecosystem services, and priority habitats within the Ecological Network.

STRATEGIC WILDFIRE RISK MITIGATION

Starting from the wildfire prevention plans established for the analyzed sites, and using the **FlamMap** DSS, several scenarios were simulated to integrate multiple management objectives:

- **No prevention** - corresponding to a non-intervention scenario;
- **Business as usual** - corresponding to the wildfire prevention measures currently included in existing plans based on expected large wildfires behaviour;
- **Business as usual optimized** – corresponding to an optimized spatial arrangement of the measures in current plans;
- **Biodiversity** – corresponding to interventions aimed at protecting target habitats, spatially arranged to limit fire spread through them;
- **Trade-off** – corresponding to interventions whose optimized spatial distribution achieves both wildfire prevention protecting wildland-urban interface and biodiversity conservation goals.

Using a multi-criteria approach, the analysis compared alternative scenarios, identifying the most effective spatial configuration of interventions that could be implemented with the available resources (**treatment of 1% of the total flammable surface**).

The objective was to reach the best compromise between biodiversity conservation and wildfire risk reduction, while also considering **civil protection** needs and the **safeguarding of key site-specific ecosystem services** (e.g., tourism infrastructure, water regulation, hydrogeological stability).

Results....

The **trade-off** scenario proved to be the most effective in reducing wildfire spread probability while minimizing impacts on biodiversity and ecosystem services compared to the other scenarios.
For example, compared to the spatial configuration of the business as usual optimized scenario, it showed a 15% reduction in wildfire risk within Habitat 9260 - Castanea sativa forests and a 64% reduction within Habitat 9530* - (Sub-) Mediterranean pine forests with endemic black pines.

These modeling results are further detailed in the "Methodological and Technical-Operational Report" available on the project website | DOWNLOAD PDF

STAND SCALE: SUPPORTING ACTIVE FIREFIGHTING AND SELF-RESISTANCE

Analysis at this scale allows for a detailed evaluation of the effectiveness and potential impact of the Close-to-Nature silvicultural prescriptions proposed within GoProForMED for conserving and/or enhancing biodiversity in the target forest habitats, while simultaneously reducing wildfire risk.

Based on the **fire ecology of forest species**, the method assesses the **conservation measures** proposed by the project in relation to **wildfire risk mitigation actions**, suggesting prescriptions that increase synergies and reduce conflicts.

In the most fire-exposed elements of the Ecological Network (Core Areas and Biodiversity Islands), interventions may be necessary **near or within these areas**, depending on local conditions.
If carried out within the habitat, the characteristics of preventive infrastructures (e.g., fuelbreaks) must be assessed in coordination with the conservation measures established for those habitats.

SYNERGIES AND POTENTIAL CONFLICTS

All Close-to-Nature silvicultural prescriptions proposed for the two analyzed habitats (9260 - Castanea sativa forests and 9530* - (Sub-)Mediterranean pine forests with endemic black pines) were evaluated against wildfire prevention criteria and classified into three categories of interaction, based on their different impacts on wildfire risk:

- **positive**, when measures support both biodiversity conservation and flammability reduction;
- **neutral**, when they have no significant effect on wildfire risk;
- **negative**, when the actions increase vulnerability to wildfires.

GOAL: INCREASE THE AMOUNT OF DEADWOOD ON THE GROUND AND STANDING

Prescriptions	Interaction	Clarifications
Do not remove the wood originated by cuts	**Negative**	Depending on the quantity, distribution, and quality of the necromass produced by the intervention
Optimize differentiation, both through cutting and girdling, of deadwood in terms of:		
• material density (accumulation of trees and individual trees)	**Negative**	Depending on the diameter growth of the trees, which determines the type of fuel released to the ground
• illumination (in light and in shade deadwood)	**Positive**	
• humidity (in valleys or depressions)	**Positive**	
• spatiality (favoring concentration over regular distribution)	**Positive**	
• type (standing or on the ground)	**Positive**	
Apply the girdling technique to:		
• gradually expose the crown of a candidate tree by causing the gradual death of its direct competitor, avoiding sudden isolation that could cause stability issues	**Negative**	Depending on the creation of a favorable condition for crown fire propagation due to the presence of a dead tree standing mixed with plants with flammable live foliage
• promote the decline of large-sized senescent trees	**Negative**	Depending on the possibility of creating conditions favorable to resin flow formation or dead trees near living ones
Promote the differentiation of deadwood types by cutting stumps at a height of 1 meter so they can also serve as anchor points for deadwood placed on the ground in areas at risk of soil erosion	**Neutral**	

Table. *As an example, the following analysis refers to Habitat 9530, examining the effects of interventions aimed at increasing deadwood (for biodiversity conservation purposes) on wildfire prevention aspects.*

Results....

Overall, the analysis showed that most of the proposed prescriptions contribute simultaneously to enhancing biodiversity and reducing wildfire risk.
All interventions aimed at:

- encouraging the presence of large trees;
- increasing species diversity;
- creating structural heterogeneity and greater discontinuity among fuel layers;

also strengthen the **forest's resistance and resilience** to potential fire spread.
The **most critical aspects**, which may conflict with wildfire prevention goals, concern:

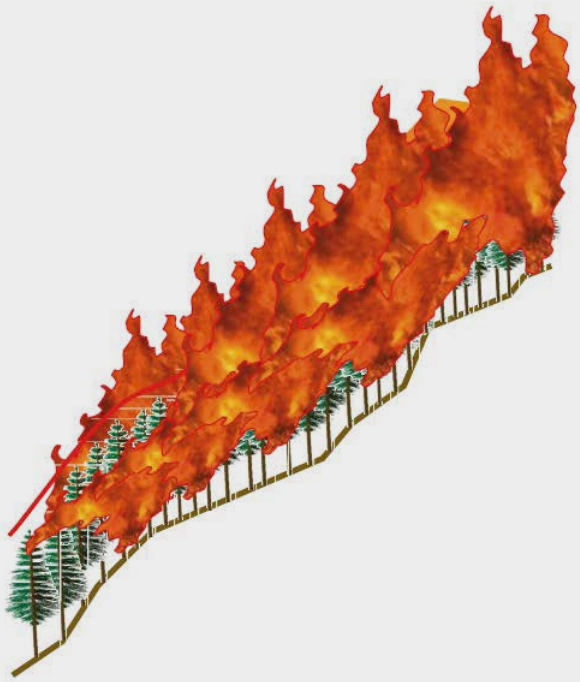
- the creation of **ladder fuels** (i.e., continuity between fuel layers);
- the management of **deadwood**.

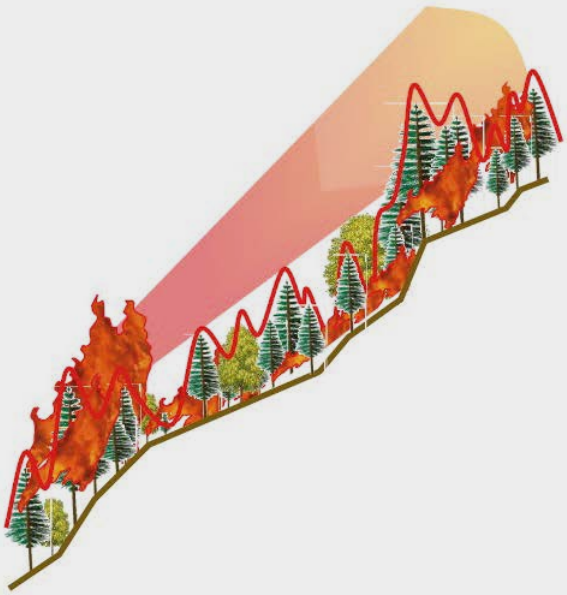
LADDER FUELS

Particularly in pine forests, during the planning and implementation of interventions, it is essential to **avoid creating conditions of vertical or horizontal continuity among vegetation layers** - for example, between the shrub layer and the crowns of dominated trees, or between regeneration, the dominated layer, and the dominant canopy. If not carefully planned, certain practices can become critical, such as

- **selective thinnings** that leave the lower layers untouched;
- retaining trees with **deep crowns**;
- creating **dense regeneration patches**.

On **sloping terrain**, it is also important to consider vertical fuel continuity, considering the spatial alignment between the convective hot air column generated by downhill trees and the flammable crowns of uphill trees.





DEADWOOD

Deadwood, a key element for biodiversity, can also increase stand flammability. Therefore, the spatial distribution of different types of released necromass, both standing and downed, must be carefully planned.

For example, **accumulations should be avoided** near Habitat Trees or other sensitive areas (drainage lines, slope changes, ridges, and firebreak roads), as well as widespread continuity of **fine necromass** (<7 cm), which plays a major role in flame propagation.

PREVENTIVE SILVICULTURE INTERVENTIONS

For prescriptions showing potential negative interactions, mitigation measures were identified, specifying where and how they should be applied with greater caution or modified to reduce risks.

The preventive silvicultural prescriptions analyzed fall into two main categories:

- **infrastructures supporting active firefighting** - structures designed to enhance firefighting capacity and safety (e.g., active green fuelbreaks, strategic management points);
- **self-resistance interventions** in forest stands - silvicultural treatments such as selective thinning, gaps creation, group selection cutting, and prescribed burning.

These interventions aim to mitigate the effects of potential wildfires by allowing, where possible, effective and safe active fire suppression or reducing stand mortality rates.

Six-step decision framework:

1. **Define the prevention target and its exposure to fire:** habitat, Core Area, Biodiversity Island, Habitat Tree;
2. **Assess the type of preventive infrastructure:** fuelbreak or self-resistance intervention;
3. **Define the spatial distribution of infrastructures:** external, perimeter, or internal;
4. **Determine infrastructure dimensions:** width of the fuelbreak zone, extent of the treatment area;
5. **Define preventive silvicultural prescriptions based on the fire ecology of dominant forest species:**
   - Type of fire: surface or crown fire;
   - Fire resistance traits: critical fire intensity;
   - Regeneration strategy: resprouting (from stump or shoots) or seed-based regeneration;
6. **Evaluate potential synergies** and conflicts and assess trade-offs with conservation measures.

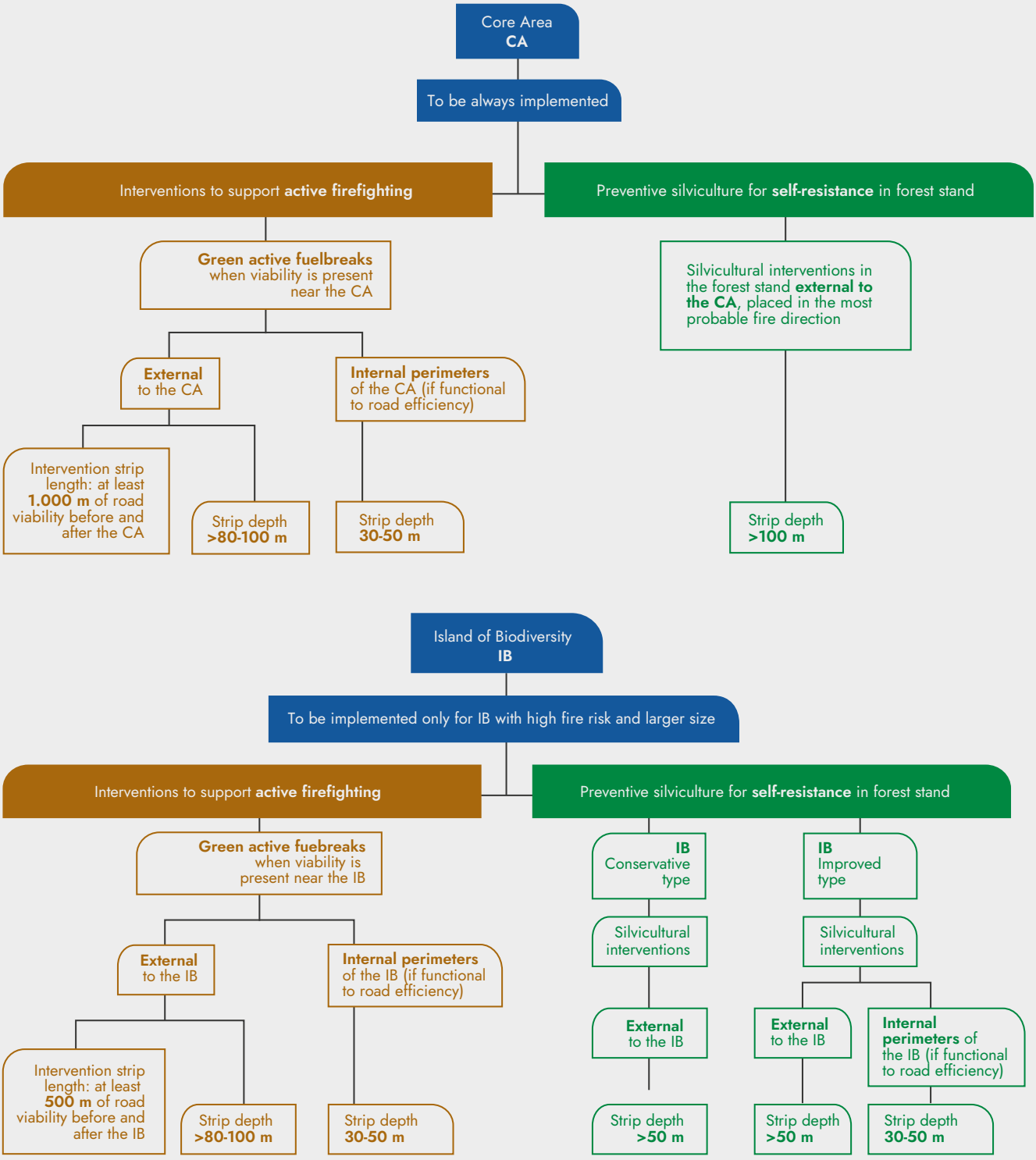


Figure. *Example of the decision framework for preventive interventions in Habitat 9530, for Core Areas and Biodiversity Islands.*

ACTIVE GREEN FUELBREAKS

These infrastructures consist of **variable-width strips, located upslope and downslope of existing roads**, where horizontal and vertical vegetation continuity is reduced to decrease flame front intensity over a sufficient distance to enhance both the effectiveness and safety of active firefighting.

Fuelbreaks are established in forest stands (both coniferous and broadleaved), shrublands, and grasslands, without compromising the general soil protection function and while ensuring the continued provision of other key ecosystem services.

Fuelbreaks must always be accessible to firefighting vehicles through entry and exit roads and equipped with water points. Their **dimensions vary depending on the vegetation type** (see Table) **and the expected behavior of the approaching flame front**.

Habitat	Network Element	Fuelbreak dimensions		
		Width (m)		Minimum length (m)
		External	Internal	
Chestnut forests (9260)	CA	50-70	20-30	1.000
	IB	70	20-30	500
Black pine forests (9530*)	CA	80-100	30-50	1.000
	IB	80	30-50	500

Table. *Guidelines for active green fuelbreaks differentiated by habitat type and Ecological Network element to be protected (Core Area - CA, Biodiversity Island - BI).*

SELF-RESILIENCE INTERVENTIONS

These interventions aim to enhance the resistance and resilience of forests to wildfire disturbance, **ensuring the persistence of forest cover** even after severe fire events- allowing post-fire successional dynamics to restart more rapidly (e.g., through seed sources).

Depending on site conditions, stand type, primary function, and expected flame front behavior, silvicultural prescriptions may include **various treatments**:

- thinnings, preparatory cuts; selection and group selection cuttings; seed-tree cuts, conversion to high forest; reforestation; surface fuel management interventions such as necromass arrangement, prescribed burning, shrub clearing, or prescribed grazing.

For self-resistance infrastructures, several aspects must be considered:

- **Civil protection priorities** - In protected areas, firefighting safety requirements take precedence, even if this entails exceptions to conservation measures;
- **Management trade-offs** - The selection of trees to retain should balance ecological and productive value with the goal of reducing crown fire transmission, adopting single-tree or group silviculture;
- **Necromass management** - Fine fractions (<7 cm) increase flame spread and intensity, whereas coarse debris has less influence on fire propagation speed but high biodiversity value. Prevention measures may involve selectively reducing fine fractions while retaining larger ones, including through prescribed burning. Necromass should be spatially distributed to avoid accumulations near Habitat Trees or drainage lines, creating spatial discontinuities (e.g., a checkerboard pattern).

CONCLUDING REMARKS

European standards call for the integration of **protected areas** and **Natura 2000 sites** into **wildfire risk analysis**, recognizing that even low-impact fires can cause management challenges. It is not always realistic to prevent fire to enter into a protected area; therefore, preventive resources must be optimized through **multi-criteria analyses that balance conservation, civil protection, rural development, and agro-silvo-pastoral activities**.

From this perspective, it is important to distinguish among:

- **sensitive habitats**, which require external protection;
- **less sensitive habitats**, where a single fire does not compromise ecological functionality;
- **habitats adapted** to specific disturbance regimes, which require active management such as prescribed burning.

Since it is impossible to completely prevent fire from entering a protected area - or the Ecological Network elements included in the Project - it is advisable to assess the need for **silvicultural interventions within these areas to increase the potential effectiveness of active suppression and self-resistance to fire within forest stands**.

Further details on the methodology, landscape- and stand-scale analytical procedures, and guidelines for mitigation and self-resilience measures are available in the full report titled: **"Technical Operational Methodological Report for Silvicultural Interventions Suitable for Reducing Fire Risk and Compatible with Conservation Objectives for Two Habitats of the Project" |** DOWNLOAD PDF

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Improvement of the conservation status of forest habitats in the Mediterranean Biogeographical Region applying restoration and conservation techniques and Close to Nature practices

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