International Workshop AFORCE

February 4th 2014, Paris

Multifunctional forest management in order to adapt Catalan forests to climate change (II)

Dra. Míriam Piqué Nicolau

Sustainable Forest Management Unit
Forest Science Center of Catalonia (CTFC), Spain

www.ctfc.cat

Catalonia (north – east Spain)

- Forest area: 2.055.000 ha (>64% of total area)

- Area covered by trees: 42% of total area

- 80% forest area, private owned

- Great diversity of tree species, forest structures and silvicultural treatments

- Great increase of forest surface and biomass accumulation in the forests, during last decades
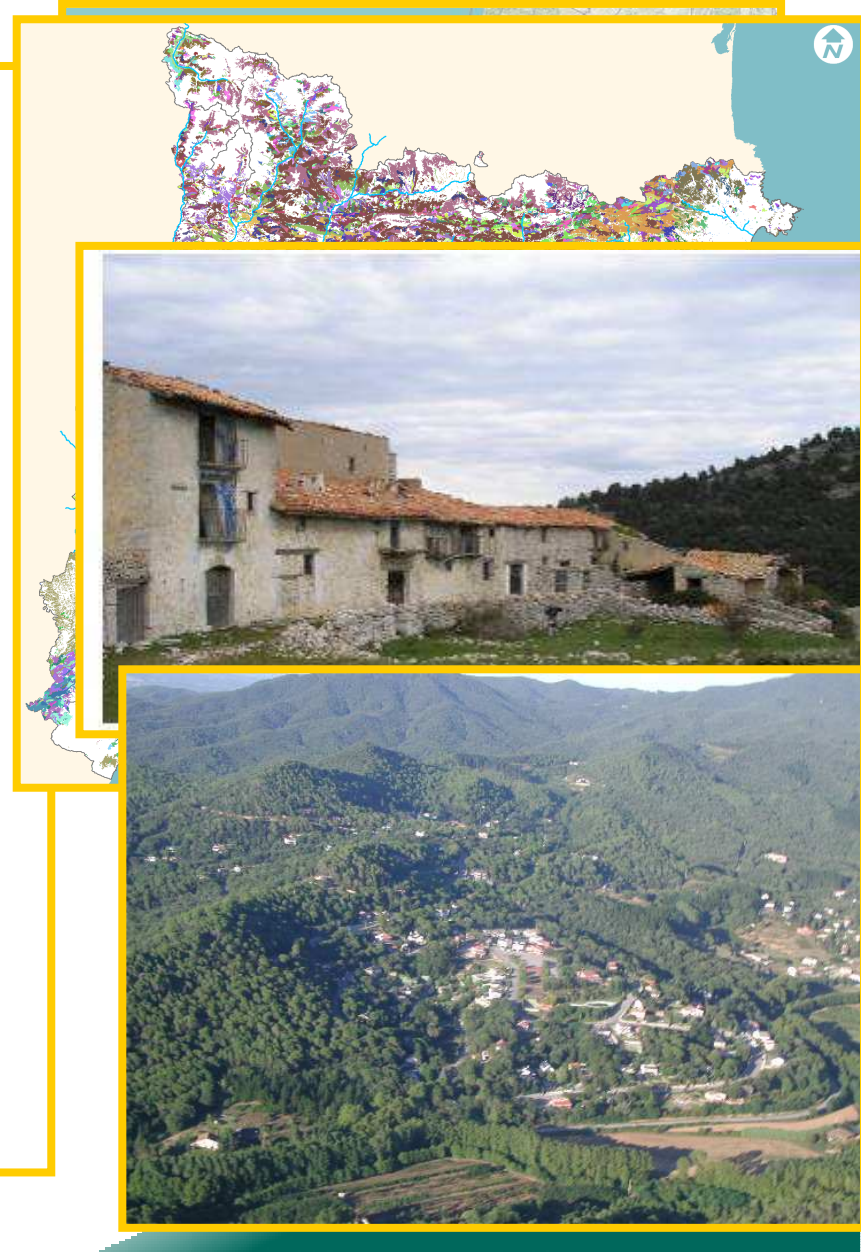
MCSC3, IFN2, IFN3, Eurostat

Forests in Catalonia: overview

Species	Total	% pure stands	% mixed stands
Pinus halepensis	294.363	69%	31%
Quercus ilex	223.062	54%	46%
Pinus sylvestris	221.874	65%	35%
Pinus nigra	127.313	48%	52%
Pinus uncinata	66.076	88%	12%
Quercus suber	60.980	46%	54%
Quercus pubescens	41.756	45%	55%
Pinus pinea	33.573	34%	66%
Quercus faginea	31.400	51%	49%
Fagus sylvatica	27.475	56%	44%
Riparian forests	24.686		
Productive plantations	42.230		
Others	123.306		

Conifers: 61%

Quercus sp: 31%

Productive plantations: 3 %

Other broadleaves and riparian forests: 5 %

www.ctfc.cat

Forest functions in Catalonia:

- Productive functions (timber and non timber products)

- Environmental functions (biodiversity, soil and water protection, etc.)

- Social functions (landscape, etc.)

Multiple-use forest management approach

Young stands

Forests in Catalonia: overview

High density, growth stagnation,
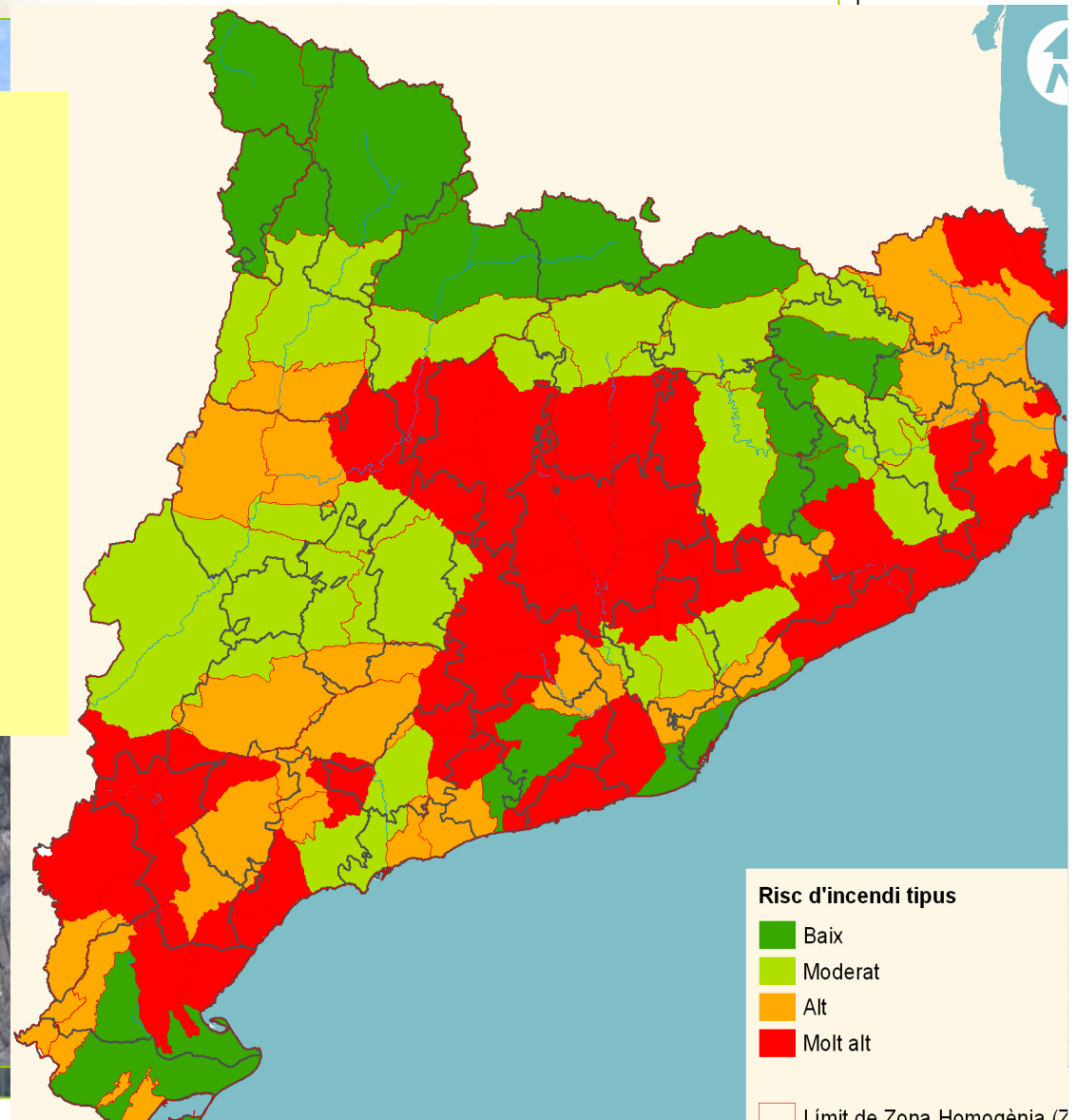poor regeneration in mature stands

Forests

Low management, lo

High fuel continuity (horizontal-vertical)

H

40% of surface very high risk of large wildfires
(red color)

(*Castellnou et al. 2010, Piqué et al. 2011*)

Risc d'incendi tipus

- Baix
- Moderat
- Alt
- Molt alt

Límit de Zona Homogènia (Z

Dry periods and global change

Main characteristics

- **Diverse forests with complex forest structure:**
  - ✓ Mixed forests
  - ✓ Different sit

- **Multifunctio**
  biodiversity,

- **Affected by**

- **Vulnerable**

- **Long histo**

* **COMPLEX F**

TIPICAL MEDITERRANEAN ECOSYSTEMS

Wich is the challenge? How to manage this complexity? Some ideas ….

- "Adaptative forest management" and "ecosystemic forest management", for the management of complex and diverse forest ecosystems.

- Forest management models and guidelines may vary, depending on the stand characteristics and objectives and they may vary, also, through time.

- Best way, is to maintain the ecosystems complexity, so the inter and intra forest stand diversity.

- If we do well done, even it can be a more economic forest management alternative.

Wich is the challenge? How to manage this complexity? Some ideas ....

- **"Multifuntional forest management",** based on the identification of **forest types** and their **vocations, as a basis** for prioritizing objectives and make them compatible

- Integration of **forest fire risk** in forest management and planning (forest fires main perturbation in Mediterranean ecosystems)

- Management and promotion of **mixed forest,** combining conifers and broadleaves, to improve forest ecosystems resilience and resistance.

ORGEST: Sustainable Forest Management Guidelines for Catalan Forests adapted to actual context of GC (2006-2013)

Project Funded by the Center of Forest Ownership of the Catalan Government

CPF, DAAM, DI,

15 working groups

FMG aims at:

a) increasing **vitality and growth** of forests

b) create **forests more resistant and resilient to forest fires**

Objectives of FMG

- **Bridging** forest planning instruments at regional level with instruments at forest stand level

- **Ensuring ecological and socioeconomical value** of forests in actual context of global change

-**Giving technical information** for an efficient achieving of management objectives and **efficient resources allocation**

ORGEST_Forest types: Forest typologies as a basis for developing forest management guidelines

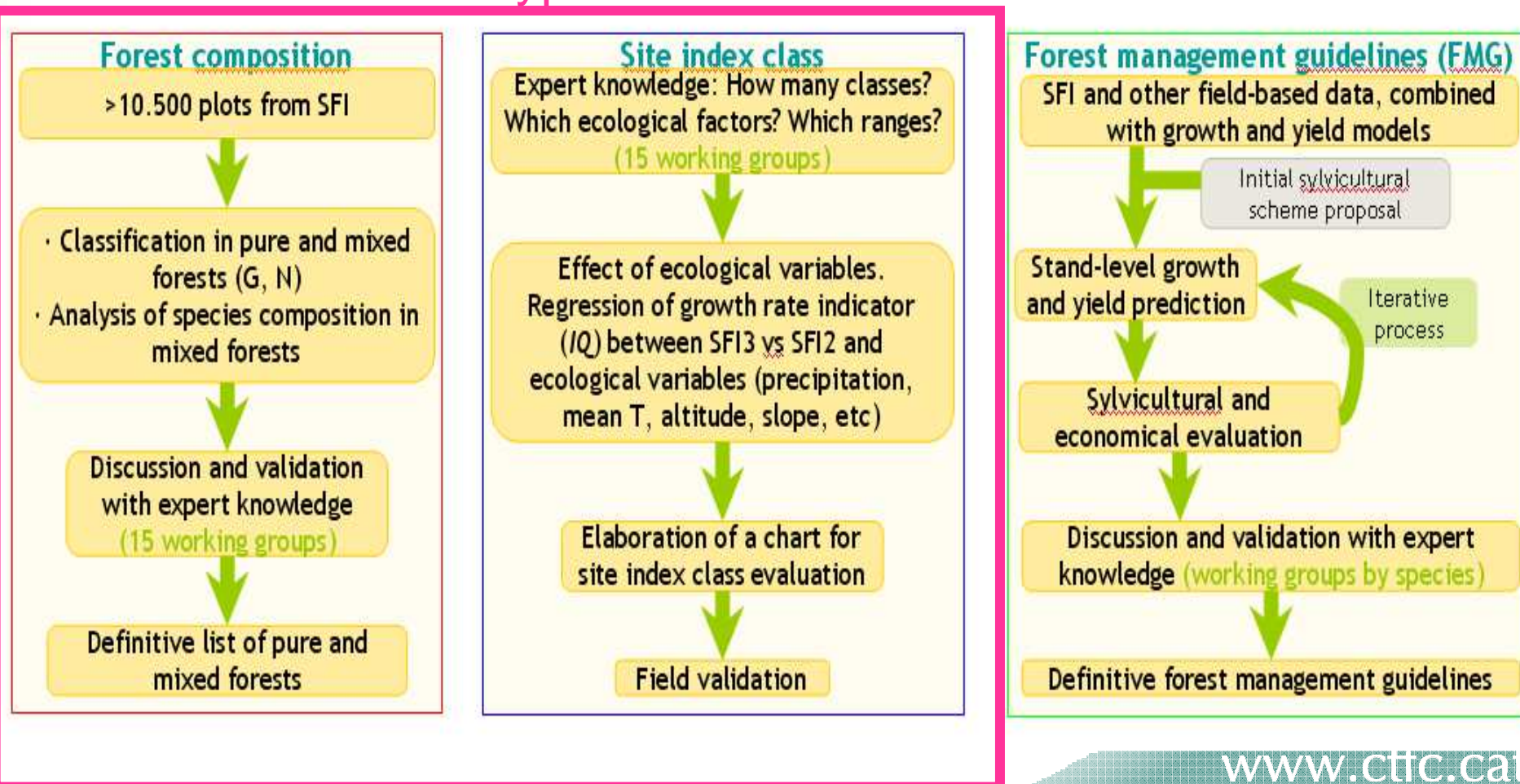**METHODOLOGY**: Prior to develop FMG a **classification of forest types (FT)** at stand level was established.
(more than 15 working groups)

Forest species composition → Forest type ← Site quality class

Other indicators and parameters important for management:
Fire risk and vulnerability, grazing value, habitat value, etc

Forest type → Main Objective → Forest management guidelines
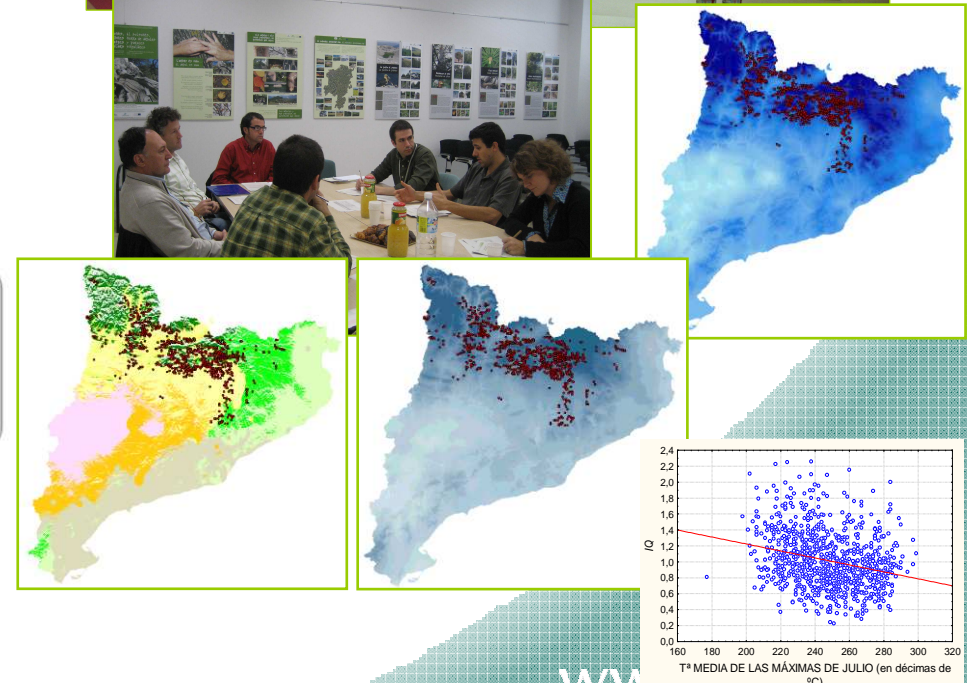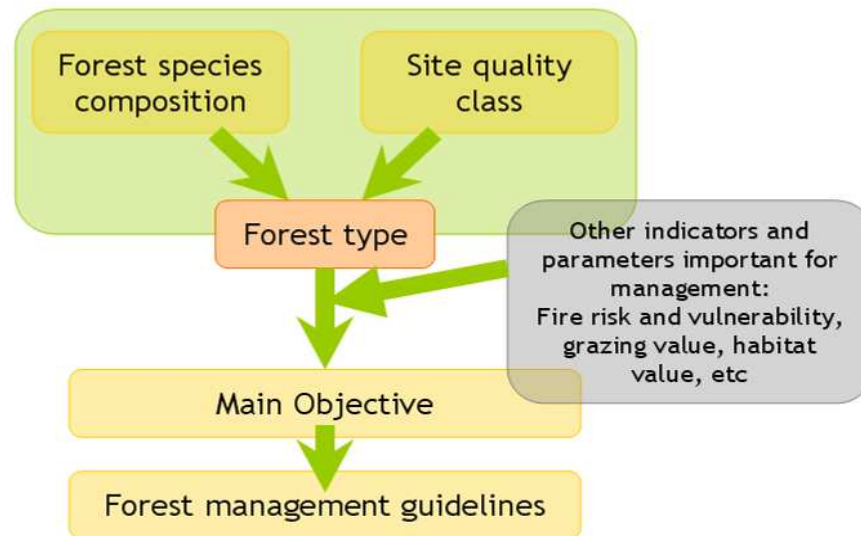
Methodology

FT and FMG were based on data from the Spanish Forest Inventories (SFI), growth and yield models and expert knowledge.

Forest types

Forest composition

>10.500 plots from SFI

↓

· Classification in pure and mixed forests (G, N)
· Analysis of species composition in mixed forests

↓

Discussion and validation with expert knowledge (15 working groups)

↓

Definitive list of pure and mixed forests

Site index class

Expert knowledge: How many classes? Which ecological factors? Which ranges? (15 working groups)

↓

Effect of ecological variables. Regression of growth rate indicator (IQ) between SFI3 vs SFI2 and ecological variables (precipitation, mean T, altitude, slope, etc)

↓

Elaboration of a chart for site index class evaluation

↓

Field validation

Forest management guidelines (FMG)

SFI and other field-based data, combined with growth and yield models

Initial sylvicultural scheme proposal

↓

Stand-level growth and yield prediction

Iterative process

↓

Sylvicultural and economical evaluation

↓

Discussion and validation with expert knowledge (working groups by species)

↓

Definitive forest management guidelines

class

w many classes?

rs? Which ranges?

roups)

al variables.

rate indicator

vs SFI2 and

precipitation,

slope, etc)

chart for

valuation

tion

Forest management guidelines (FMG)

SFI and other field-based data, combined with growth and yield models

Initial sylvicultural scheme proposal

Stand-level growth and yield prediction

Iterative process

Sylvicultural and economical evaluation

Discussion and validation with expert knowledge (working groups by species)

Definitive forest management guidelines

We have worked in the development of **tools for Fire risk assessment at stand level**

(to asses vulnerability of forest stands to generate crown fires)

As a basis for:

- **Providing specific FMG** with the objective to reduce crown fires hazard, in areas specially susceptible to large wildfires.

- FMG are required to be **easy to implement**, **efficient** in terms of Large forest fires (LFF) risk reduction and **economically sustainable**.

Types of fires in relation to the fuel involved in the propagation
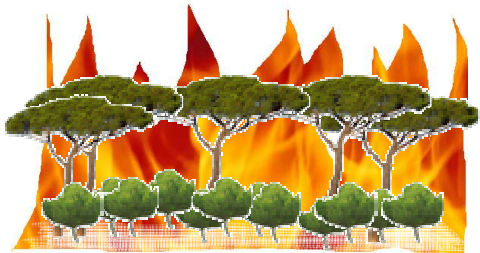
Active crown fires

Passive crown fires

Surface fires

Methodology   Integration of wildfires in FMG

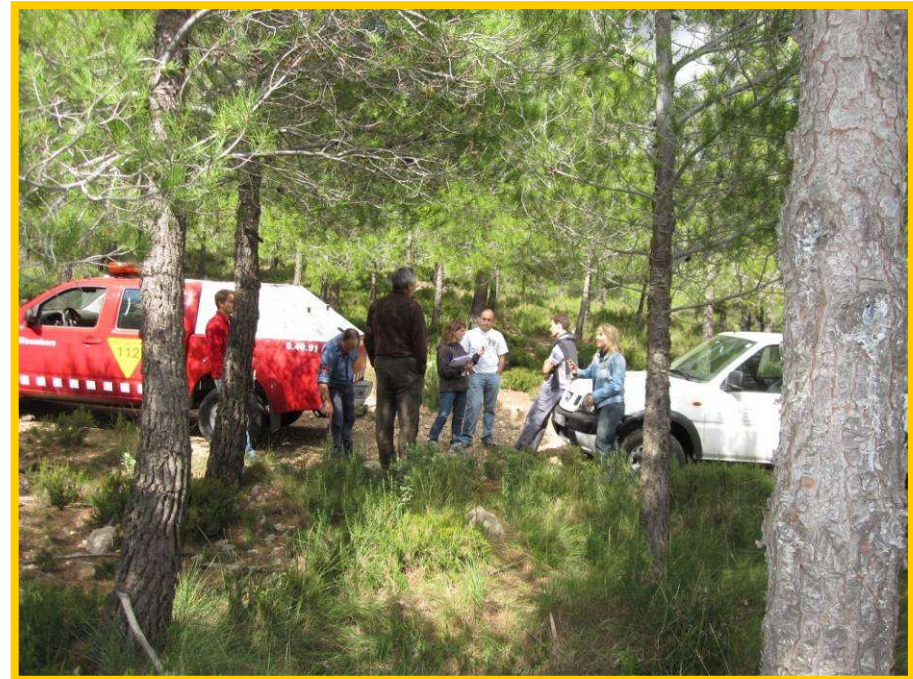## Crown fire hazard chart (CFHC) for main forest species in Catalonia

Expert opinion approach

Definition of fuel types, selection of silvicultural variables and threshold values

↓

Design and development of CFHC

↓

Verification of CFHC in the field

(Piqué *et al.,* 2011)

Actual tools for forest managers and forest owners to support their decisions

- Tool for the identification of **forest types** at stand level and their capacity to adapt and growth.

- **FMG for pure and mixed forests**

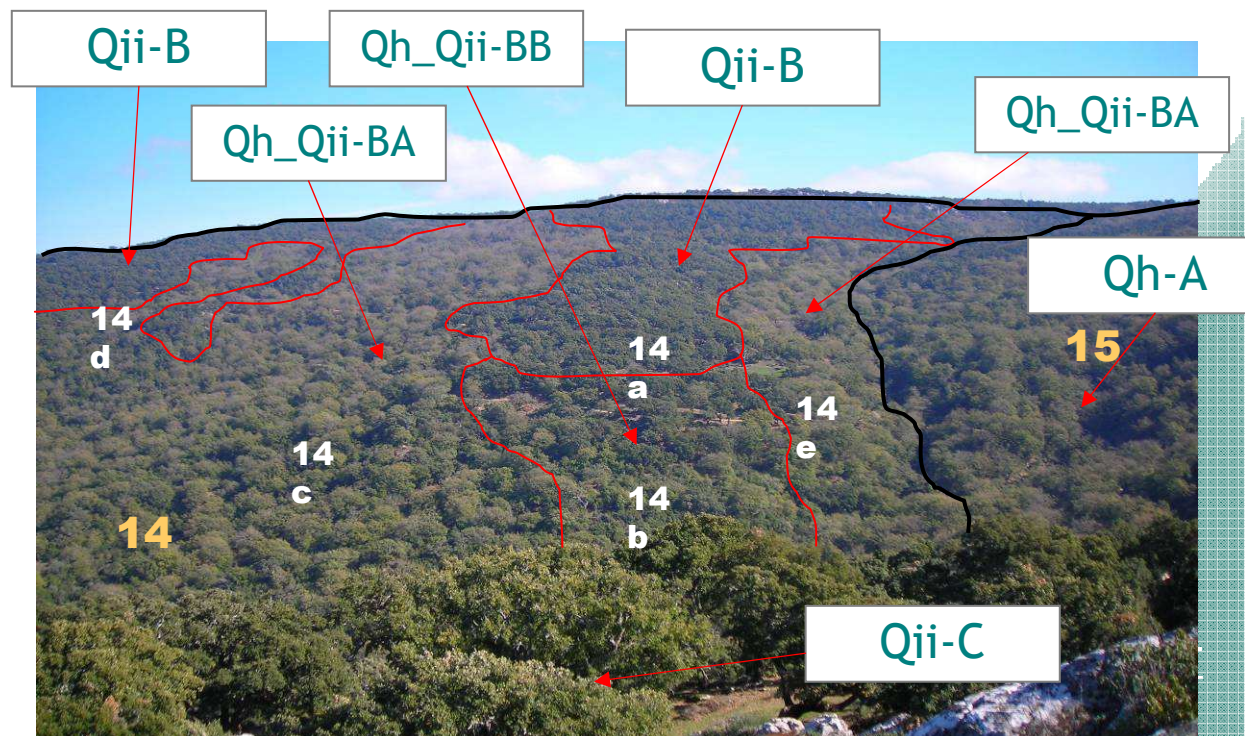- Tool for **assessing vulnerability of forest stands to generate crown fires**

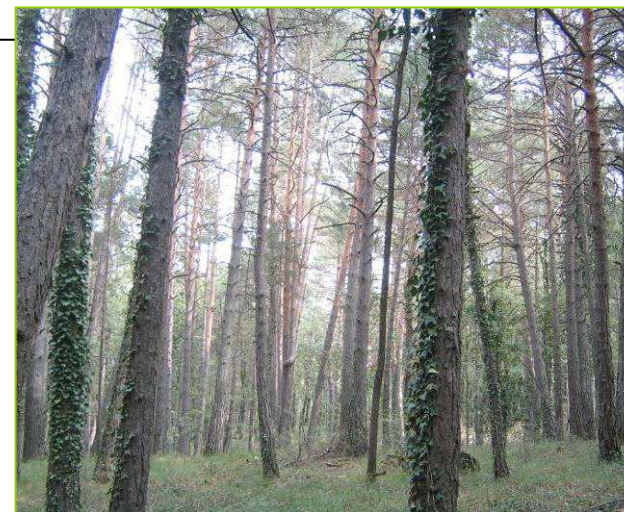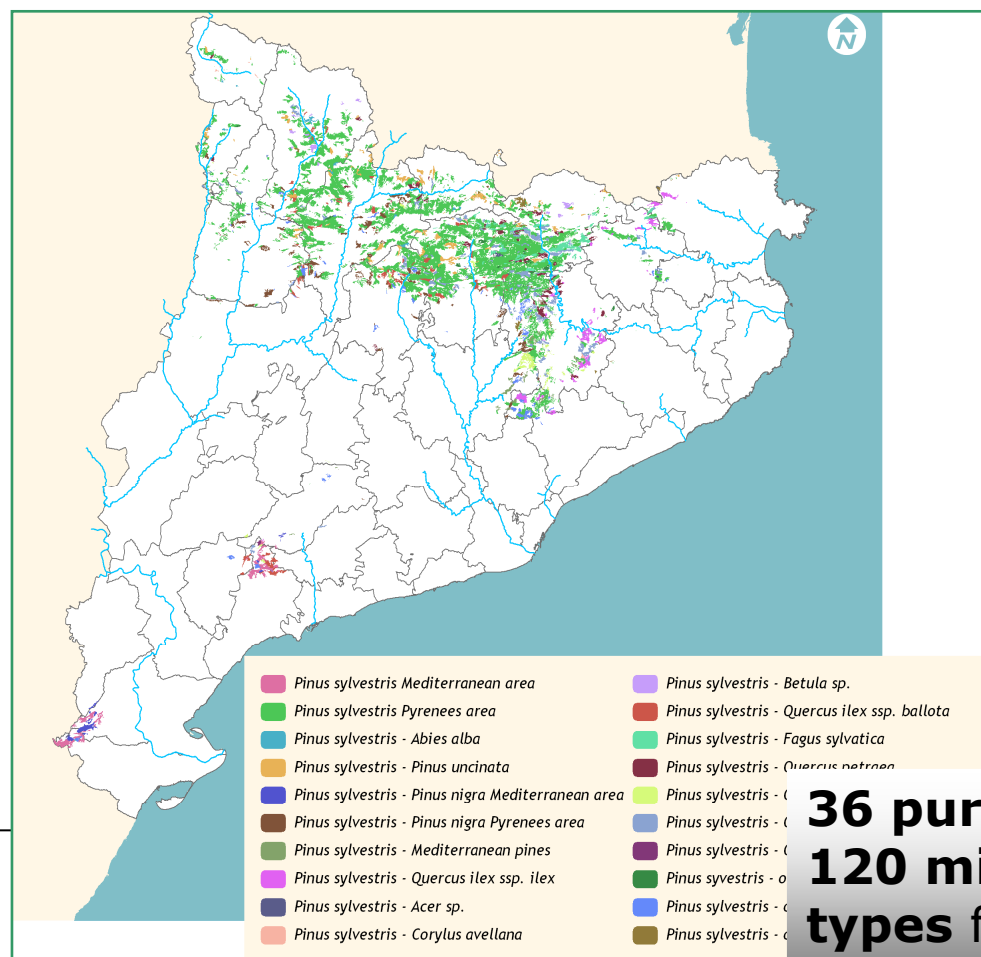# Actual tools for forest managers and forest owners to support their decisions

- Tool for the identification of **forest types** at stand level and their capacity to adapt and growth

Forest types

Species composition:

Legend:

- Pinus sylvestris Mediterranean area
- Pinus sylvestris Pyrenees area
- Pinus sylvestris - Abies alba
- Pinus sylvestris - Pinus uncinata
- Pinus sylvestris - Pinus nigra Mediterranean area
- Pinus sylvestris - Pinus nigra Pyrenees area
- Pinus sylvestris - Mediterranean pines
- Pinus sylvestris - Quercus ilex ssp. ilex
- Pinus sylvestris - Acer sp.
- Pinus sylvestris - Corylus avellana

- Pinus sylvestris - Betula sp.
- Pinus sylvestris - Quercus ilex ssp. ballota
- Pinus sylvestris - Fagus sylvatica
- Pinus sylvestris - Quercus petraea
- Pinus sylvestris -
- Pinus sylvestris -
- Pinus sylvestris -
- Pinus syvestris - o
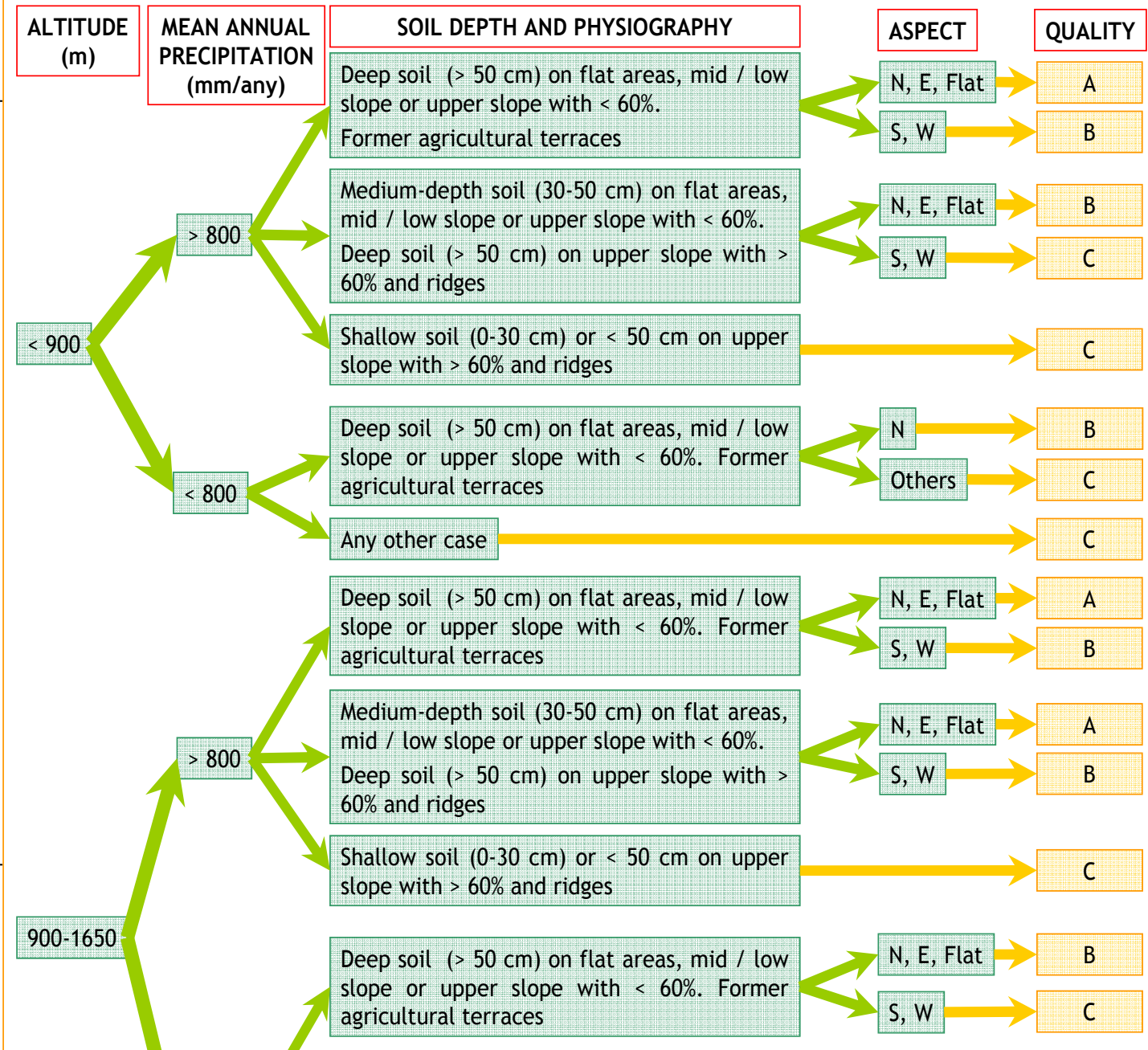- Pinus sylvestris -
- Pinus sylvestris -

36 pure forest types, 120 mixed forest types for Catalonian region

www.ctfc.cat

Site quality

SITE QUALITY CHART
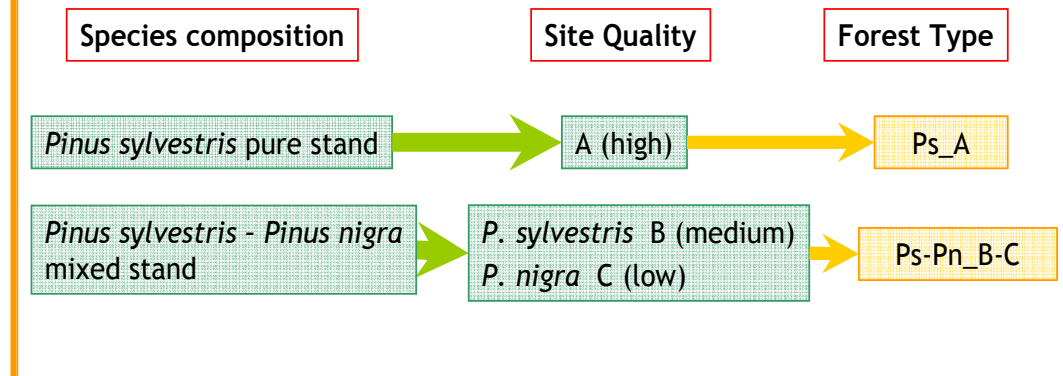## FOREST TYPE: SCOTCH PINE AT CENTRAL CATALONIA AND PYRENEAN AREA

ALTITUDE (m)	MEAN ANNUAL PRECIPITATION (mm/any)	SOIL DEPTH AND PHYSIOGRAPHY	ASPECT	QUALITY
< 900	> 800	Deep soil (> 50 cm) on flat areas, mid / low slope or upper slope with < 60%. Former agricultural terraces	N, E, Flat	A
			S, W	B
		Medium-depth soil (30-50 cm) on flat areas, mid / low slope or upper slope with < 60%. Deep soil (> 50 cm) on upper slope with > 60% and ridges	N, E, Flat	B
			S, W	C
		Shallow soil (0-30 cm) or < 50 cm on upper slope with > 60% and ridges		C
	< 800	Deep soil (> 50 cm) on flat areas, mid / low slope or upper slope with < 60%. Former agricultural terraces	N	B
			Others	C
		Any other case		C
900-1650	> 800	Deep soil (> 50 cm) on flat areas, mid / low slope or upper slope with < 60%. Former agricultural terraces	N, E, Flat	A
			S, W	B
		Medium-depth soil (30-50 cm) on flat areas, mid / low slope or upper slope with < 60%. Deep soil (> 50 cm) on upper slope with > 60% and ridges	N, E, Flat	A
			S, W	B
		Shallow soil (0-30 cm) or < 50 cm on upper slope with > 60% and ridges		C
		Deep soil (> 50 cm) on flat areas, mid / low slope or upper slope with < 60%. Former agricultural terraces	N, E, Flat	B
			S, W	C

Forest types: integration of everything in Forest Planning

Stand tipification

FOREST TYPES

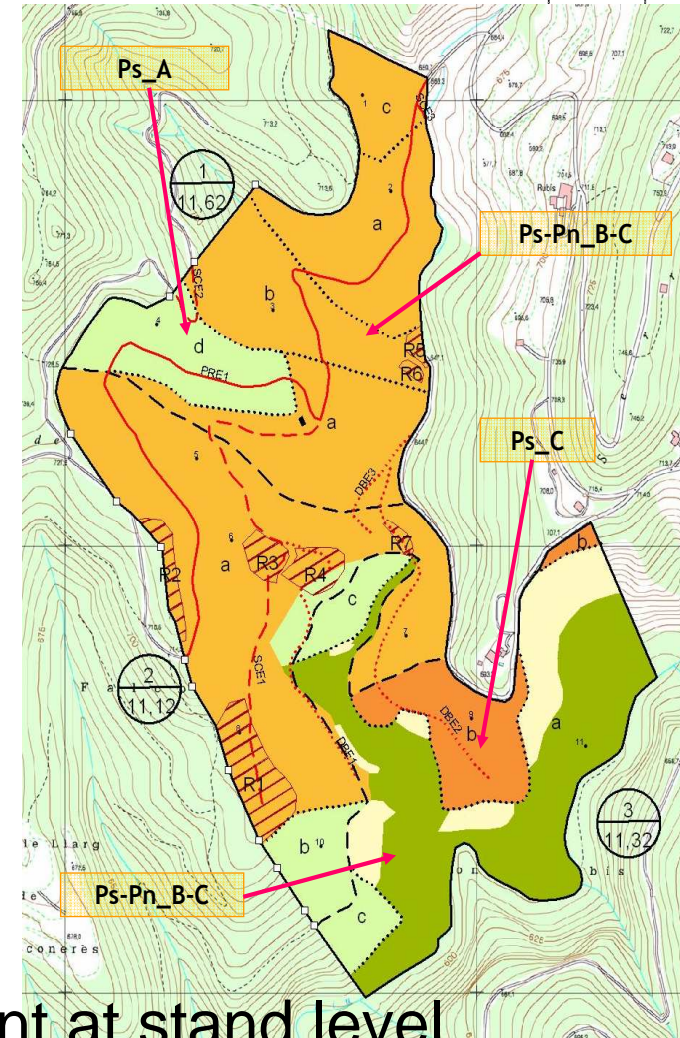| Species composition	Site Quality	Forest Type
Pinus sylvestris pure stand	A (high)	Ps_A
Pinus sylvestris - Pinus nigra mixed stand	*P. sylvestris* B (medium) *P. nigra* C (low)	Ps-Pn_B-C

Forest type A: FMGA1, FMGA2, FMGA3, MFGA4, ….

Forest type B: FMGB1, FMGB2, FMGB3, MFGB4, ….

….

Approach, to adapt forest management at stand level

Ps_A

Ps-Pn_B-C

Ps_C

Ps-Pn_B-C

Forest planning map

Actual tools for forest managers and forest owners to support their decisions

- F**MG** for pure and
mixed forests

FMG for main forest specie in Catalonia (ORGEST)

FMG for 10 species and their forest types (wide range of options ......)

- **85 models for pure stands** (even and uneven aged forests) = *f* (site quality, vulnerability of stand to large forest fires, main objectives)

- **54 models,** from the previous 85 models, integrates forest fire prevention, through creating and keeping forest structures with low vulnerability to generate crow fires (let's say forest structures resistant to forest fires)

- **9 models** are exclusively to reduce crown fire hazard, leaving in a secondary level the objective of production

- **197 models for mixed forest stands** (related to FMG for pure stands) = *f* (natural dynamics)

Quantitative models, including the most typical silvicultural variables, description of treatments and codes of good practices

www.ctfc.cat

Actual tools for forest managers and forest owners to support their decisions

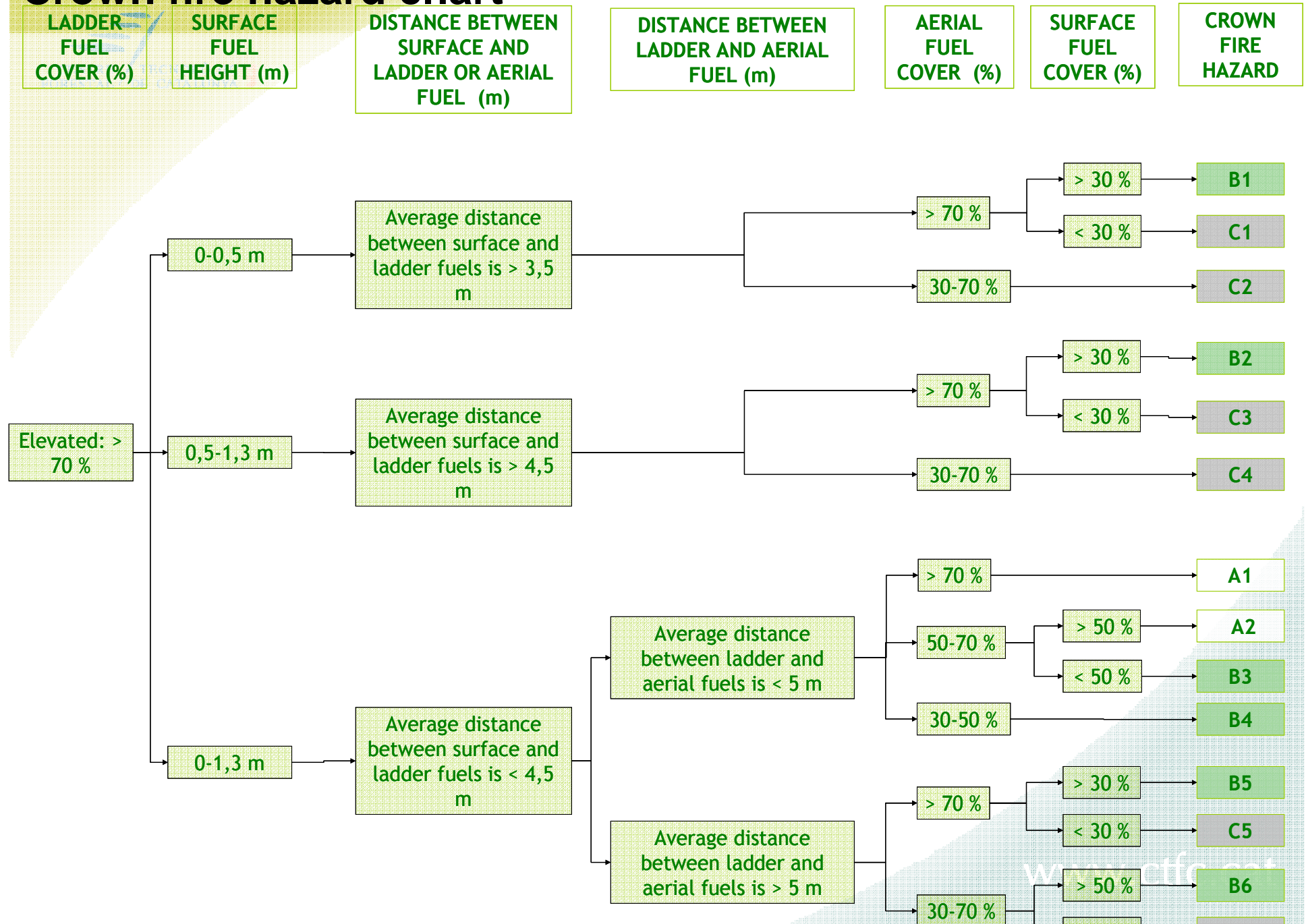- Tool for **assessing vulnerability** of forest stands to generate **crown fires**

To **increase resistant of forest to LFF**, we suggest following principles:

1) Treatments to **reduce forest fuel should be in strategic areas** facing the prevention and suppression of forest fires at the mountain scale.

2) Treatments should cause **changes in forest structure** and **influence fire behaviour** in the desired way.

3) Treatments should take into account the **natural dynamics** and based in adaptive management.

4) Minimal intervention treatments, **low cost** and its **effect should last a** maximum time.

What are the target forest structures?

Crown fire hazard chart

LADDER FUEL COVER (%)	SURFACE FUEL HEIGHT (m)	DISTANCE BETWEEN SURFACE AND LADDER OR AERIAL FUEL (m)	DISTANCE BETWEEN LADDER AND AERIAL FUEL (m)	AERIAL FUEL COVER (%)	SURFACE FUEL COVER (%)	CROWN FIRE HAZARD

Elevated: > 70 %

- **0-0,5 m** → Average distance between surface and ladder fuels is > 3,5 m
  - **> 70 %**
    - **> 30 %** → B1
    - **< 30 %** → C1
  - **30-70 %** → C2

- **0,5-1,3 m** → Average distance between surface and ladder fuels is > 4,5 m
  - **> 70 %**
    - **> 30 %** → B2
    - **< 30 %** → C3
  - **30-70 %** → C4

- **0-1,3 m** → Average distance between surface and ladder fuels is < 4,5 m
  - Average distance between ladder and aerial fuels is < 5 m
    - **> 70 %** → A1
    - **50-70 %**
      - **> 50 %** → A2
      - **< 50 %** → B3
    - **30-50 %** → B4
  - Average distance between ladder and aerial fuels is > 5 m
    - **> 70 %**
      - **> 30 %** → B5
      - **< 30 %** → C5
    - **30-70 %**
      - **> 50 %** → B6

- **Crown fire hazard chart for *Pinus halepensis***
  - Total of 38 types of forest structures
  - Ranked as:
    - A (high vulnerability to active crown fire)
    - B (moderate, passive crown fire)
    - C (low, surface fire)

Piqué, M.; Castellnou, M.; Valor, T.; Pagés, J.;
Larrañaga, A.; Miralles, M.; Cervera, T. 2011.

http://ags.ctfc.cat/?p=649
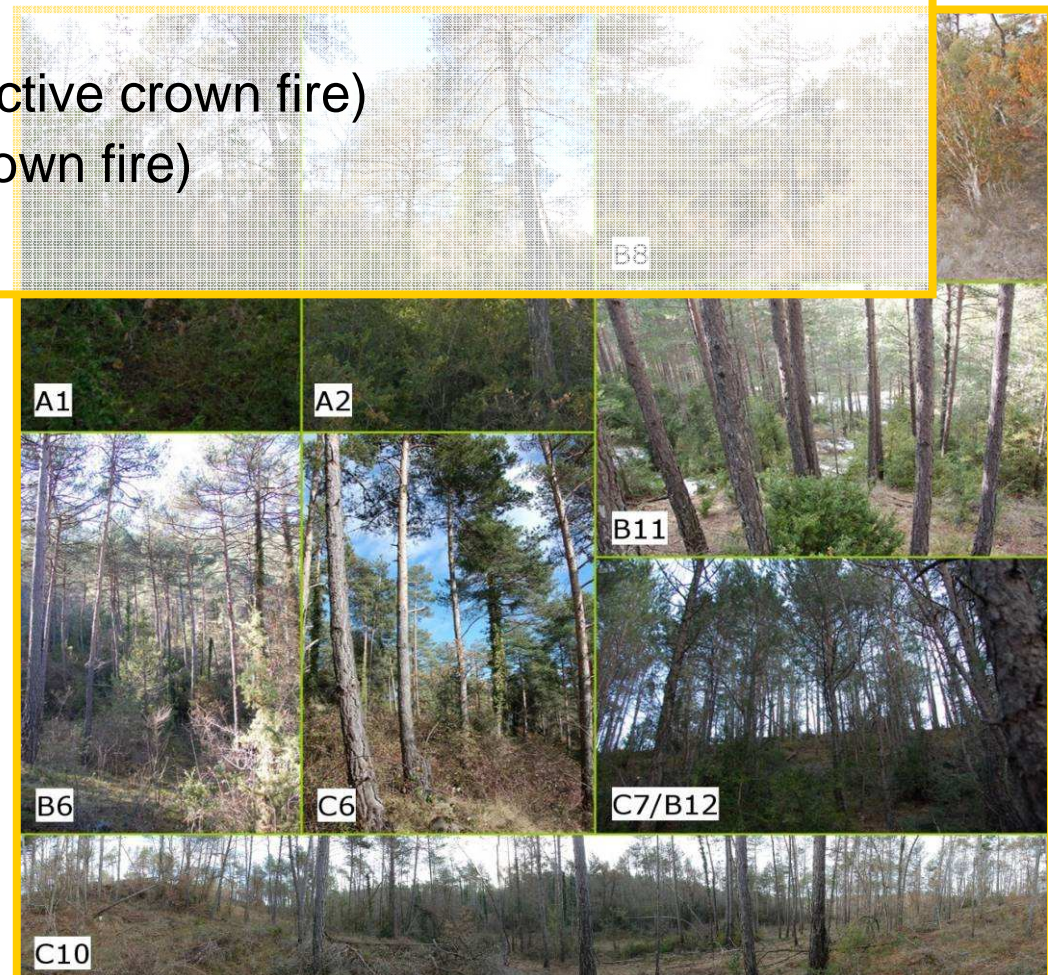
Definition of treatments

Boscos amb Fcc >70%
RCE >70%
Estructures A1, B3 i B5

MODEL PS15
ESTRUCTURA INICI1

- Information about the types of forest structures (A, B or C) serves us to:

  1) Identify **stand crown fire hazard**

  2) To orientate forest management to **create fire resistant structures** that facilitate fire extinction tasks

  3) **Provide managers with numerical** data to help in fuel management decision making processes

El fet de poder diferenciar un estrat de vegetació entre el matollar inferior a 1,3 m i l'inici de les capçades del dosser dominant implica que aquests boscos són més o menys adults i amb certa alçada, sobretot pel que fa al dosser de pins, que es troba ben desenvolupat.

w.ctfc.cat

- Basin of Rialb river (Prepirenees)
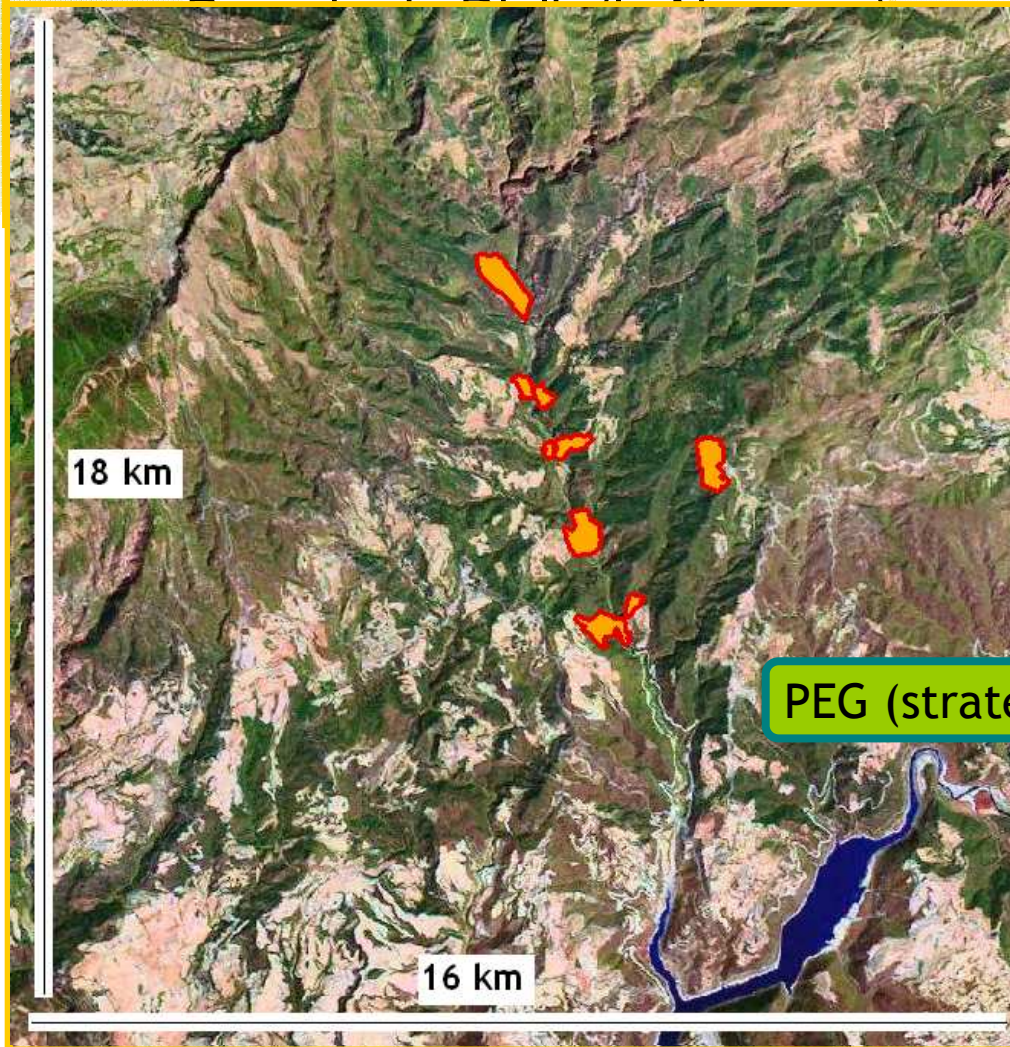
Strategic points of Management:

- Create resistant forest structures to crown fires

- Create forest structures that can alter forest fire propagation, and facilitate extinction tasks

PEG (strategic point) GRAF, CPF

18 km

16 km

www.ctfc.cat

- Forest type

- Forest stand structure (variables N, G, Dm, Do, Hm, Ho)

- Crown fire hazard classification

	6,95 ha	RODAL 1

Orientació: Est **Altitud:** 450-530 m **Pendent:** 50%

Bosc de pinassa de l'àmbit prepirinenc i central (PnPRE).

Fcc: 60% **N:** 600-800 peus/ha **AB:** 15-18 m²/ha **H₀:** 12-13 m

Descripció:

Massa pura de *Pinus nigra* Arn. acompanyat per quercines, principalment *Quercus pubescens* Willd. Els peus de roure es distribueixen individualment i arriben a formar part de l'estrat superior. Hi ha presència de peus aïllats d'auró.

Estructura irregularitzada amb presència de tres cohorts. Massa oberta i descapitalitzada, s'observen soques velles. Hi ha abundància d'arbres dominats, petits no vitals, i presència d'arbres tombats.

Els pins formen l'estrat dominant entre el qual apareixen roures que conformen l'estrat de combustible d'escala, juntament amb els boixos de major alçada.

El sotabosc és mitjanament abundant, format principalment per boix amb peus grans, amb presència de garric i càdec. L'estrat herbaci cobreix gairebé tota la superfície, format principalment per fenàs.
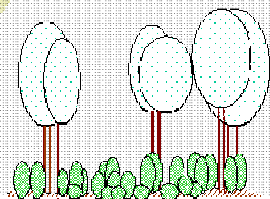
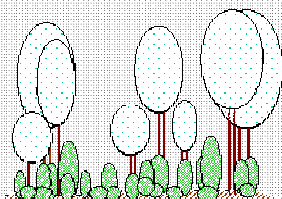Pedregositat baixa però amb presència d'afloraments rocosos.

| RECOBRIMENT DEL COMBUSTIBLE D'ESCALA (%)	DISTÀNCIA ENTRE EL COMBUSTIBLE DE SUPERFÍCIE O D'ESCALA I L'AERI (m)	DISTÀNCIA ENTRE EL COMBUSTIBLE DE SUPERFÍCIE I D'ESCALA (m)	FRACCIÓ DE CABUDA COBERTA DEL COMBUSTIBLE AERI (%)	RECOBRIMENT DEL COMBUSTIBLE DE SUPERFÍCIE (%)	VULNERABILITAT AL FOC DE CAPÇADES
Abundant: > 70 %	La distància mitjana entre el combustible d'escala i l'aeri és < 5 m	La distància mitjana entre el combustible de superfície i d'escala és < 3 m	> 70 %		A1
			50-70 %	> 50 %	A2
				< 50 %	B1
			30-50 %		B2
		La distància mitjana entre el combustible de superfície i d'escala és > 3 m	> 70 %	> 30 %	B3
				< 30 %	C1
			30-70 %	> 50 %	B4
				< 50 %	C2
	La distància mitjana entre el combustible d'escala i l'aeri és > 5 m		> 70 %	> 30 %	B5
				< 30 %	C3
			30-70 %		C4
Mitjanament abundant: 25-70 %	La distància mitjana entre el combustible d'escala i l'aeri és < 5 m	La distància mitjana entre el combustible de superfície i d'escala és < 3 m	> 70 %	> 40 %	A3
				< 40 %	B6
			30-70 %	> 60 %	A4
				< 60 %	B7
			30-50 %		B8
		La distància mitjana entre el combustible de superfície i d'escala és > 3 m	> 70 %	> 50 %	B9
				< 50 %	C5
			30-70 %	> 70 %	B10
				< 70 %	C6
	La distància mitjana entre el combustible d'escala i l'aeri és > 5 m		> 70 %	> 30 %	B11
				< 30 %	C7
			30-70 %		C8
			> 70 %	> 70 %	A5
				30-70 %	B12

Definition of final forest structures
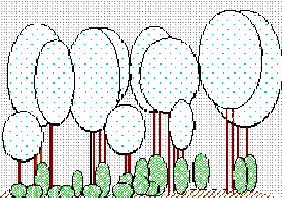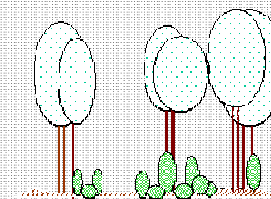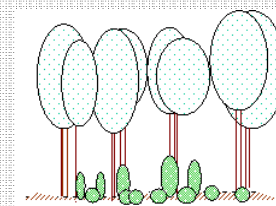
- # Reduction of ladder fuels (<25%)
  - Eliminate urderstory superior to 1,3 m
  - Eliminate dominant trees with crowns in contact.
  - Keep small trees (priority *Quercus* sp.), where there is no other trees around and no problem of vertical continuity

- # Reduction of surface fuels (<30%)
  - Selective clearings

- # Management of slash originated in the treatments
  - Cut the slash with diameter > 5 cm in pieces 0,8-1 m long. Distribute the slash on the floor
  - Prescribed burning
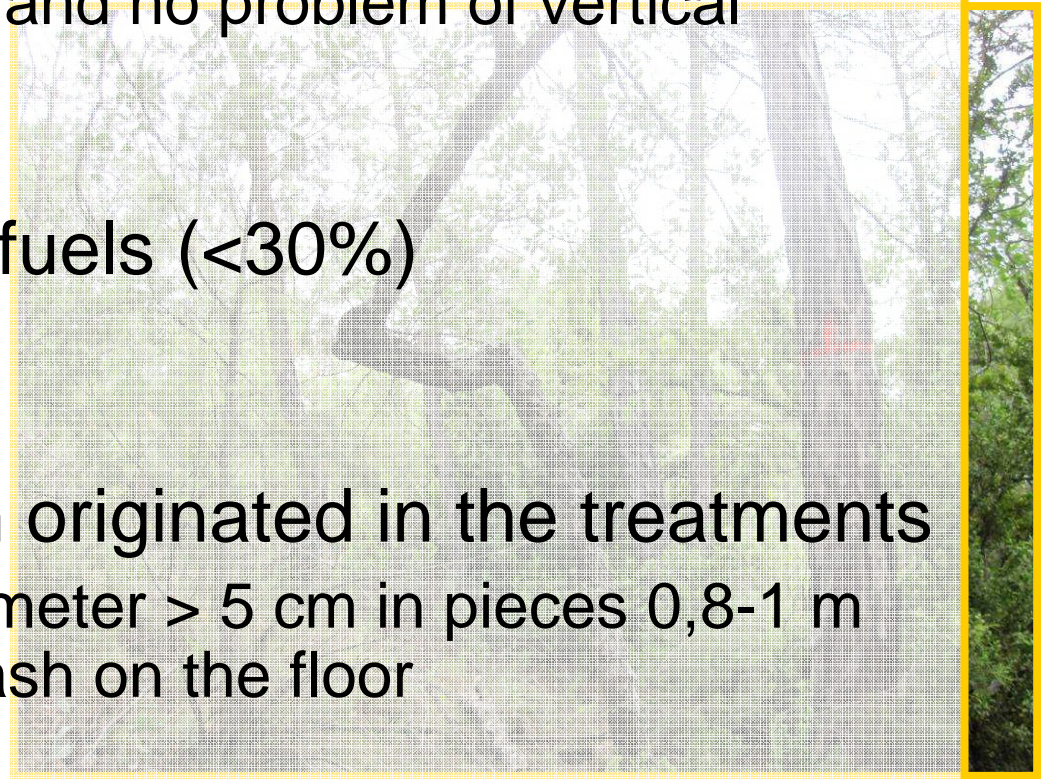
■ **Simulations for Pre fuel treatment and post fuel treatment scenarios (Nexus): Crown fire hazard simulation**
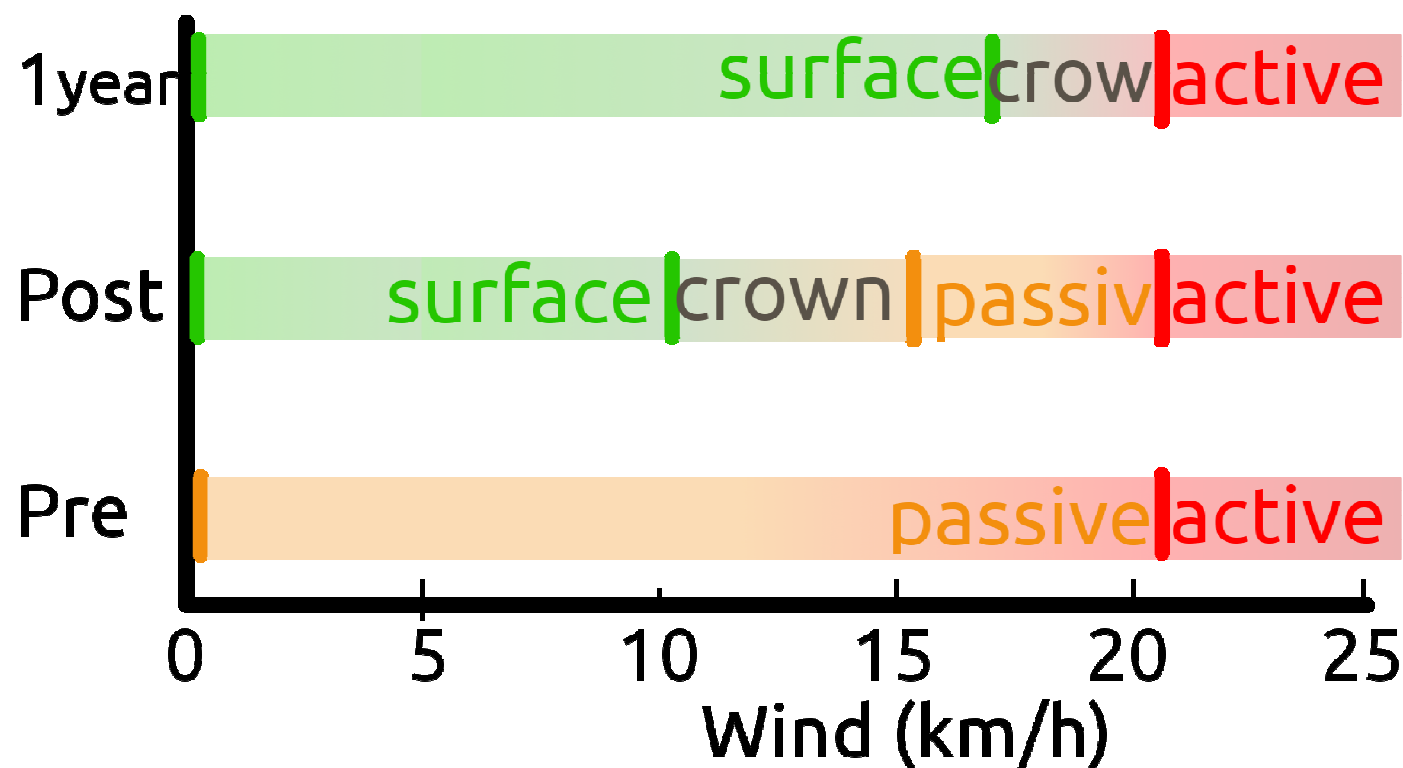
■ Fuel treatments were effective in reducing the vulnerability of the stand to crown fire when wind speeds are in under **20 km/h**.

ORGEST Publications

Tools for practical diagnosis of forest stands

Forest Management Guidelines + Code of good practices
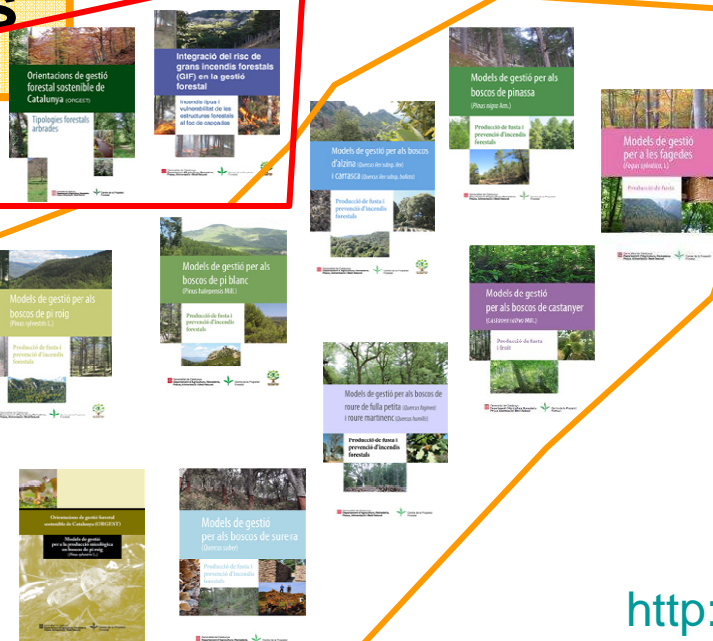
FMG for most important forest types in Catalonia, covering the **84% of forest surface** (pure and mixed forests): 11 books published

http://ags.ctfc.cat/?p=649

Publication about Adaptive Forest Management
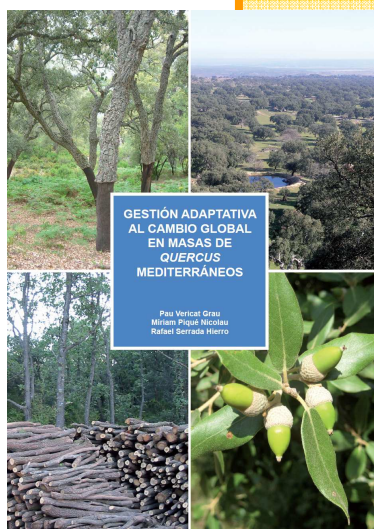
"Adaptive forest management to global change in Mediterranean *Quercus*"

(Vericat, Piqué and Serrada, 2012)

http://ags.ctfc.cat/?p=55

www.ctfc.cat

"Lesson learned"

Implication of forest sector (forest owners, technician, researchers, administration, industry) in the process

"Challenges"

Implementation (put in practice), Divulgation, Demonstration, Capacity Building, Formation and specialization, Forest valorisation, Forest policy

DEMORGEST project …

Thank you

Acknowledgments

Centre de la Propietat Forestal.

Unitat Tècnica del Grup de Recolzament a les Actuacions Forestals (GRAF) del Departament d'Interior de la Generalitat de Catalunya.