www.mixforchange.eu

Life MixForChange project: management for climate change adaptation of mixed Mediterranean sub-humid forests

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1. Principles of (Mediterranean) adaptive silviculture

2. Introduction to LIFE MixForChange project

3. LIFE MixForChange silviculture

1. Principles of (Mediterranean) adaptive silviculture

1.1. Main aims

Increase the **resistance** and the **resilience** of forest ecosystems to disturbances (drought, fire, pests and diseases)

Resistance: capacity to maintain its integrity (low vulnerability)

Resilience: capacity to recover to the pre-disturbance state

How can we increase resistance & resilience?

1. Principles of (Mediterranean) adaptive silviculture

1.1. Main aims

1.2. Silviculture and density

How does this look like?

1. Principles of (Mediterranean) adaptive silviculture

1.1. Main aims

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What about this?

1. Principles of (Mediterranean) adaptive silviculture

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Intermediate density:

- Forest microclimate: dark and wet
- High individual vigour

1. Principles of (Mediterranean) adaptive silviculture

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1.3. Silviculture and species composition

What is more resistant + resilient to drought, fire, pests?

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Mixed forests:

At least 2 species providing 20% or more of total basal area

Complex systems:

Mixture spatial scale: tree by trees? Small groups? Large groups? Stands / properties? Landscape? Micro-sites?

Time scale: static or dynamic mixture? Incipient / juvenile / adult stage?

Species involved: number of species? Functional diversity? Light demands? Root pattern? Crown shape and density? Growth rate? Age? Longevity?

Very difficult to understand, model, manage

1. Principles of (Mediterranean) adaptive silviculture

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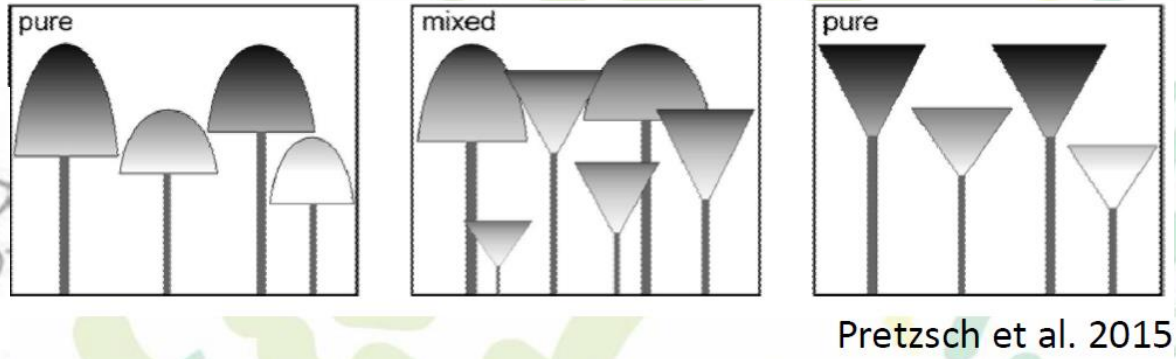
Mixed forests and complementarity



Pretzsch et al. 2015

Use of resources (water, light, soil) along time (1D) and space (3D)

1. Principles of (Mediterranean) adaptive silviculture

1.1. Main aims
1.2. Silviculture and density
1.3. Silviculture and species composition
1.4. Silviculture and disturbances

Mediterranean context: drought and fire

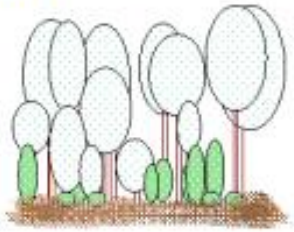
Drought: intermediate density, promote vigorous trees (healthy, dominant, seed origin)

Fires: break vertical fuel continuity

1. Principles of (Mediterranean) adaptive silviculture

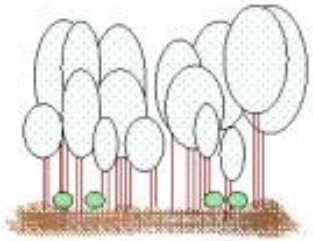
TIPUS D'ESTRUCTURES D'ALTA VULNERABILITAT AL FOC DE CAPÇADES

A1



- PF: > 10 cm
- RCE: > 70%
- De-a: < 4 m
- Df-e: < 1,5 m
- FCC: qualsevol

A2



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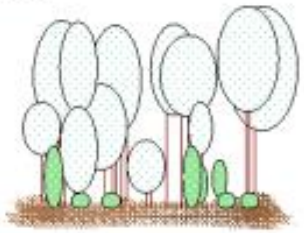
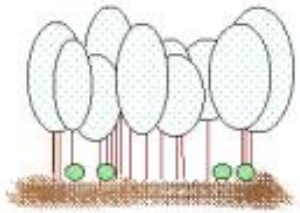
A3



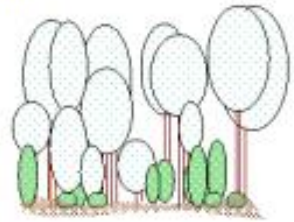
- PF: > 10 cm
- RCE: 25-70%
- De-a: < 4 m
- Df-e: < 1,5 m
- FCC: > 70%

A4



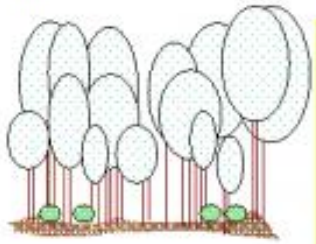
- PF: > 10 cm
- RCE: 0-25%
- Df-a: < 3 m
- Df-e: qualsevol
- FCC: > 70%

A5



- PF: < 10 cm
- RCE: > 70%
- De-a: < 3,5 m
- Df-e: < 1 m
- FCC: qualsevol

A6



- PF: < 10 cm
- RCE: > 70%
- De-a: < 3,5 m
- Df-e: > 1 m
- FCC: > 70%

Piqué et al, 2011
Integrating risk of large wildfires in sustainable forest management

1. Principles of (Mediterranean) adaptive silviculture

1.1. Main aims
1.2. Silviculture and density
1.3. Silviculture and species composition
1.4. Silviculture and disturbances
1.5. Conclusions: how to implement Med adaptive silviculture?

- Promote the most healthy and vigorous trees
- Density regulation: avoid too high and too low
- Mixed forests: more diversity → more resilience
- Break vertical fuel continuity

…not forgetting that silviculture requires ecologic + economic sustainability

2. Introduction to LIFE MixForChange project

Project origin

Very simplified stands in Mediterranean sub-humid conditions

Common problems of these forests

- <u>Vulnerable</u> to drought, fire
- Abandonment → excessive density, low stability and vitality
- Low added-value products
- Periurban forests: high social demands: soil, water, biodiversity..

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Presence of (spontaneous + scattered) valuable broadleaves: an opportunity!

2. Introduction to LIFE MixForChange project

Project objectives

Main aim: to contribute to the adaptation and enhanced resilience to climate change of **mixed Mediterranean sub-humid forests in Europe**, promoting their conservation state and the maintenance of their productive, ecological and social functions.

1. Developing, implementing and demonstrating innovative adaptive silviculture
2. Developing new tools for integrating forest CC adaptation in the policy framework.
3. Develop new tools to strengthen forest management economics to foster its economic sustainability in the mid and long term and to prevent forest abandonment
4. Transfer the techniques and tools to the main regional and European stakeholders

Timespan: 10/2016 to 09/2021

Project partners:

CTFC

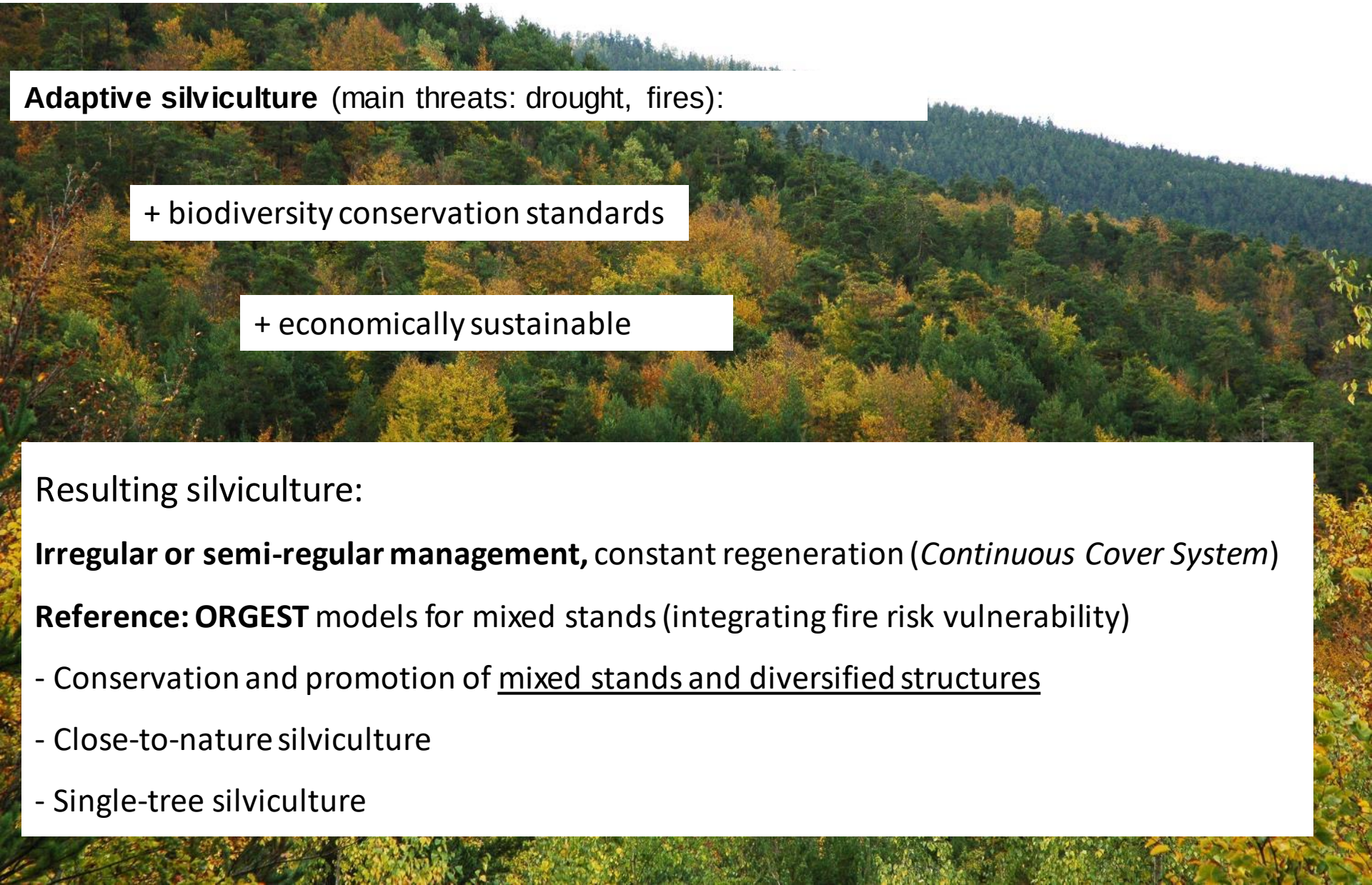
Generalitat de Catalunya
Departament d'Agricultura, Ramaderia, Pesca i Alimentació

Centre de la Propietat Forestal

serra de bellmunt
associació de propietaris forestals

Diputació Barcelona

Developing, implementing and demonstrating innovative adaptive silviculture



Adaptive silviculture (main threats: drought, fires):

+ biodiversity conservation standards

+ economically sustainable

Resulting silviculture:

Irregular or semi-regular management, constant regeneration (*Continuous Cover System*)

Reference: ORGEST models for mixed stands (integrating fire risk vulnerability)

- Conservation and promotion of mixed stands and diversified structures
- Close-to-nature silviculture
- Single-tree silviculture

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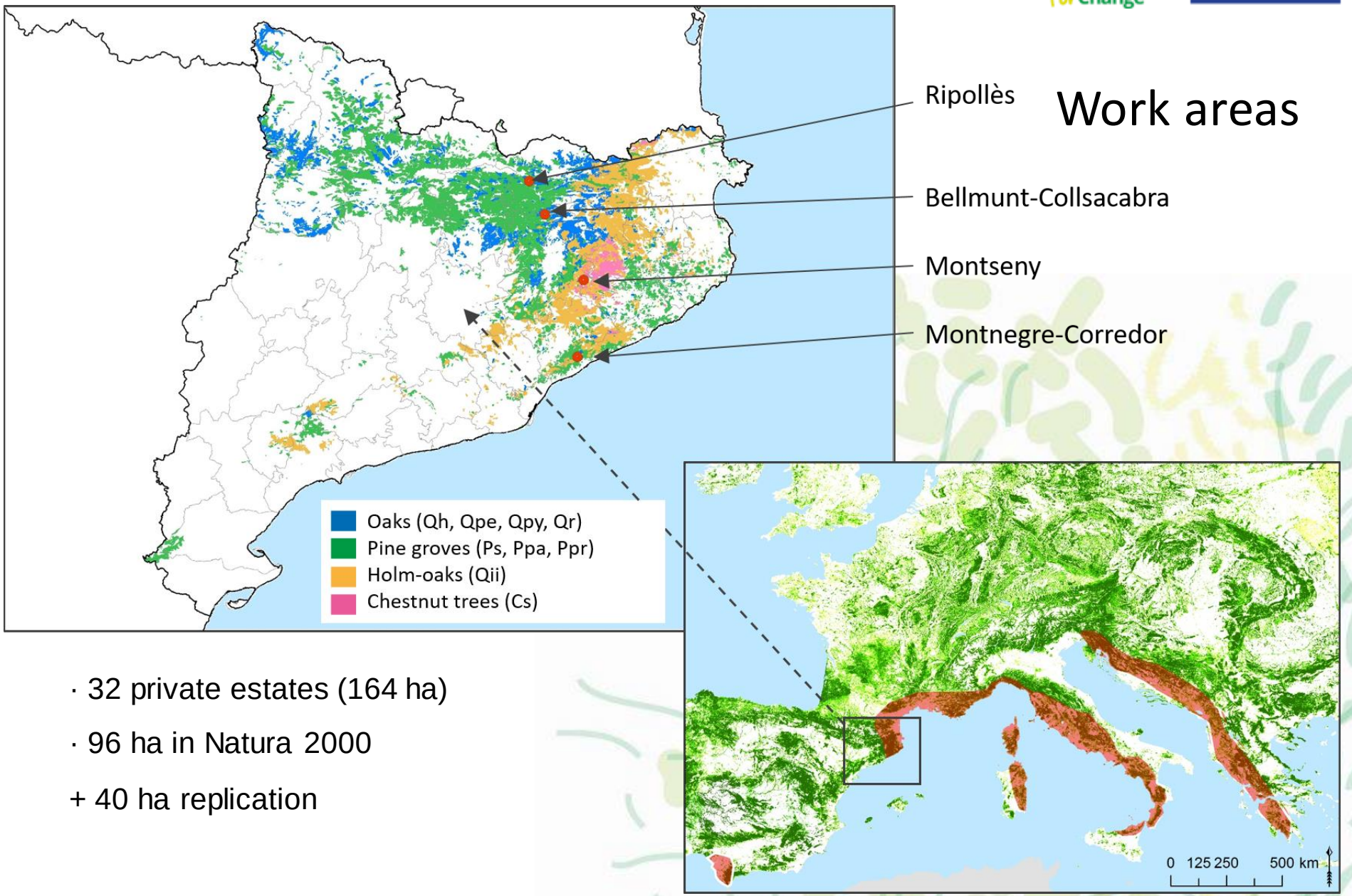

· 32 private estates (164 ha)

· 96 ha in Natura 2000

+ 40 ha replication

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Chestnut forests

Castanea sativa

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Holm oak forests

Quercus ilex ssp. *ilex*

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Oak forests

Quercus pubescens, Q. petraea, Q. canariensis

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Pine forests

Pinus sylvestris, P. pinea

3. LIFE MixForChange silviculture

- Adaptive silviculture

- Close to nature silviculture

- Single tree silviculture

Promote the most healthy and vigorous trees

Selective thinnings

Density regulation: avoid too high and too low

Selective thinning intensity: 25-30% BA

Mixed forests: more diversity → more resilience

Keep all the present species; promote least abundant ones

Enrichment planting

Break vertical fuel continuity

Selective clearing of shrubs taller than 1.3 m

3. LIFE MixForChange silviculture

- Adaptive silviculture

- Close to nature silviculture

- Single tree silviculture

Take benefit of <u>natural processes favorable</u> to management aims:

- Forest microclimate → less shrub development, more self-pruning
- Juvenile stages with high competence: not intervention
- Shred and leave cut debris on the ground (moisture + soil shading)
- Leave standing some dead trees (when not dangerous to workers)

<u>Detailed silviculture</u>: application based on micro-site conditions

Tree marking by skilled staff

3. LIFE MixForChange silviculture

- Adaptive silviculture

- Close to nature silviculture

- Single tree silviculture

Identification of **most valuable trees** in terms of...

- **adaptation**: keep all species, vigorous seed trees

- **conservation**: scarce species, trees with microhabitats or special features

- **economics**: valuable timber species, good shape, potential for high price

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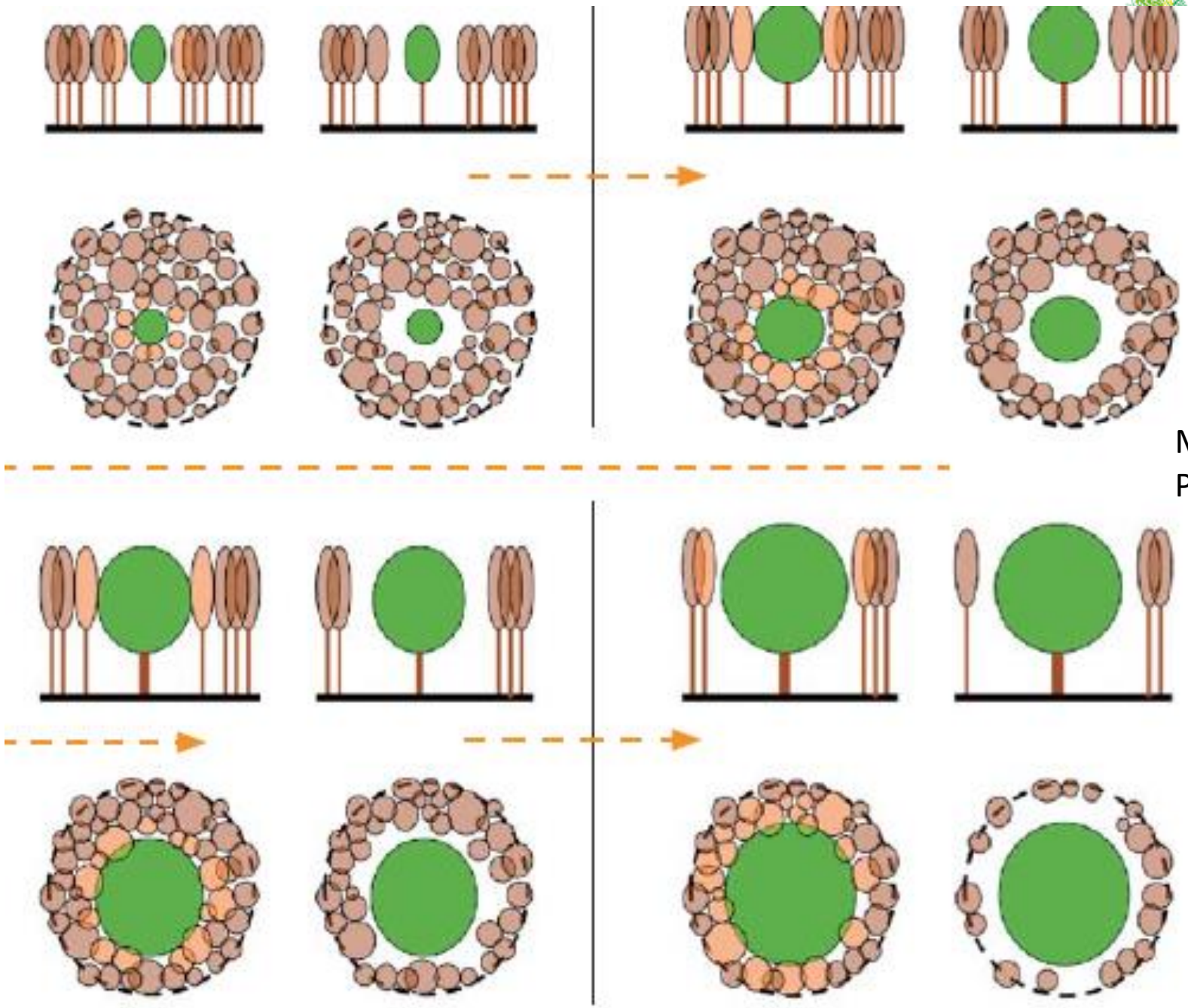
...and promoting them with selective thinning (1-2 competitors)



Mori &
Pelleri, 2014

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MixForChange silviculture

Irregular or semi-regular management, constant regeneration (*Continuous Cover System*)

Reference: ORGEST models for mixed stands (integrating fire risk vulnerability)

+

Close-to-nature management criteria

Single-tree oriented silviculture

Treatments (diversification, competence reduction)

Depending on stand type and structure: **selective** and/or **mixed thinning** OR **coppice with standards**, always considering criteria of tree-oriented silviculture

Partial + selective shrub clearing

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Future crop tree selection (150 trees/ha)

Tree cutting criteria

1st: Competitors at crown level of future crop trees

2nd: General regulation of competence (selective or mixed thinning), to reach the parameters defined at stand level

Most common thinning intensity: 25-30% BA

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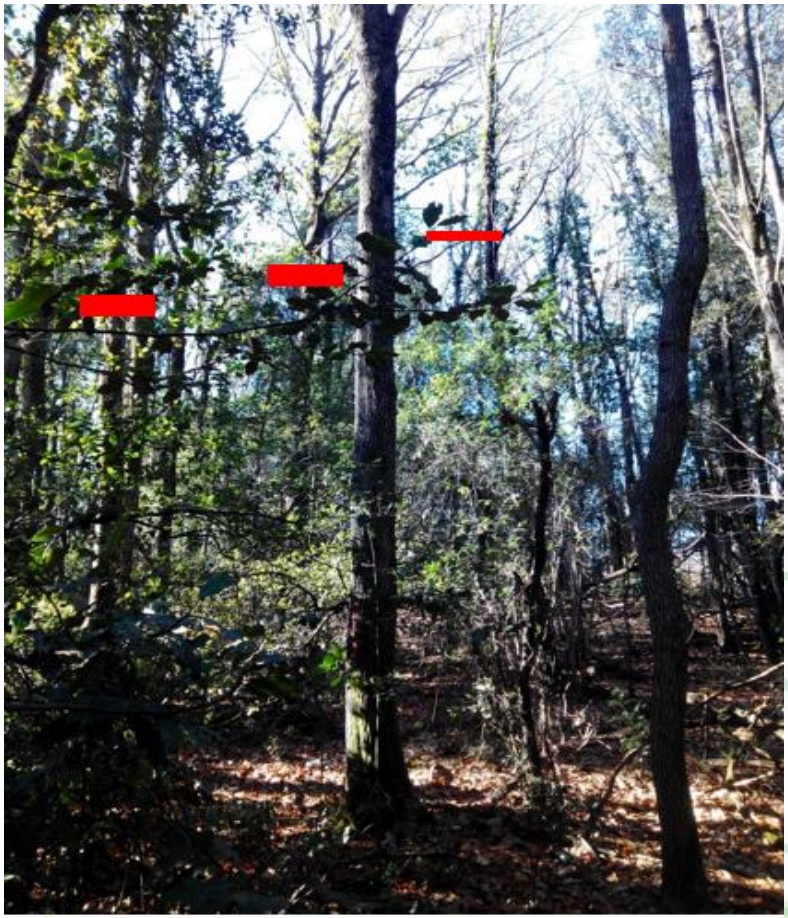
Releasing adult future crop trees, regulating competence at the dominant and co-dominant strata



Releasing future crop trees of young broadleaves (DBH>7.5 cm): identification of competitors at crown level

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Example: interventions in chestnut stands (*Castanea sativa*)

Mixed or selective thinning, coppice with standards:

- Chestnut, *Quercus sp*: cut 50% shoots + dead shoots
- *Erica sp*, *Arbutus unedo, Viburnum sp*: 1-2 shoots/stump left (0 if dead/malformed)
- Hazelnut stumps: cutting peripheral shoots

Release future crop trees: *Prunus avium, Quercus sp. Sorbus sp., Fraxinus sp, Acer sp*

1 – 2 competitors cut

Selective shrub clearing

Dasometric figures:

Ni = 1350 trees/ha Cut: ≈540 trees/ha

BAi = 29 m^2/ha ≈-24% BA(7 m^2/ha)

≈ 100-150 future crop trees/ha (oak, cherry...)

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Interventions monitoring

SILVO-DASOMETRIC

· Characterize the interventions
· Assess the stand response

- Dasometric variables
- Structural vulnerability to forest fires
- Understory
- Future crop trees: up to 15 trees
- Regeneration

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Interventions monitoring

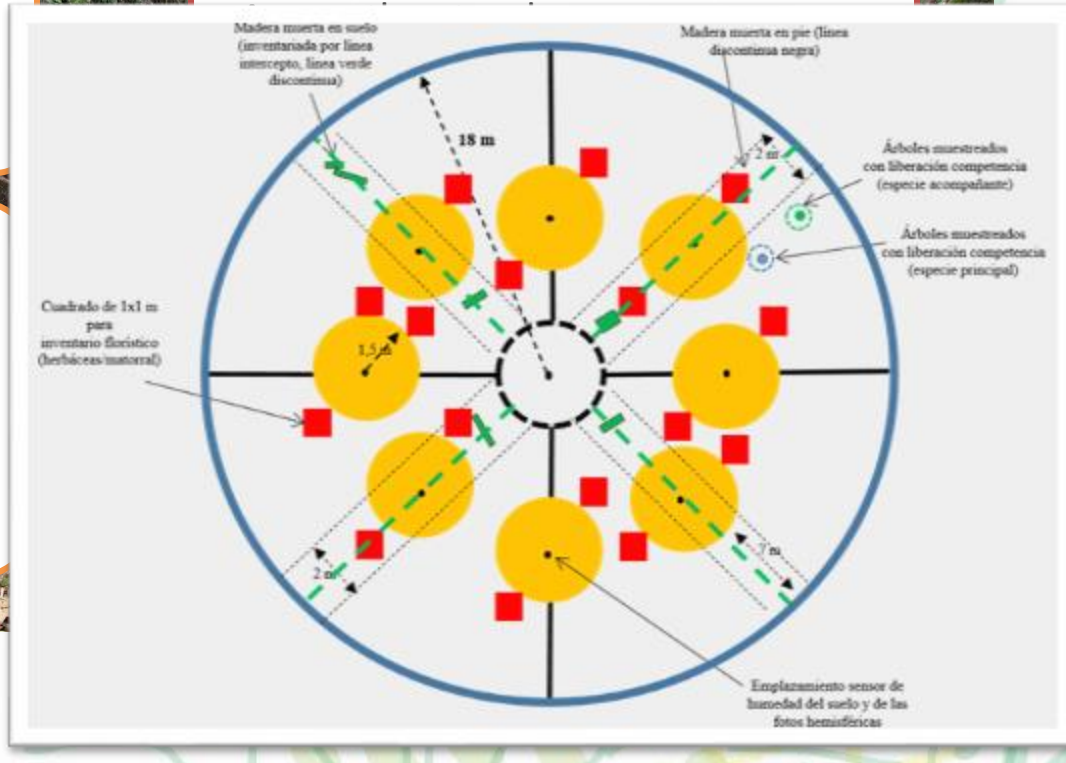
ECOLOGIC

- Assess the impact of the intervention on CC adaptation
- Assess key functions: biodiversity, water regime

- 20 trees with dendrometer + dimensions and competence
- 8 sub-plots: regeneration, flora
- 2 transects of dead wood
- 8 hemispheric pictures
- 9 moisture sensors
- Available light, soil profile and depth

SILVO-DASOMETRIC

- Characterize the intervencions



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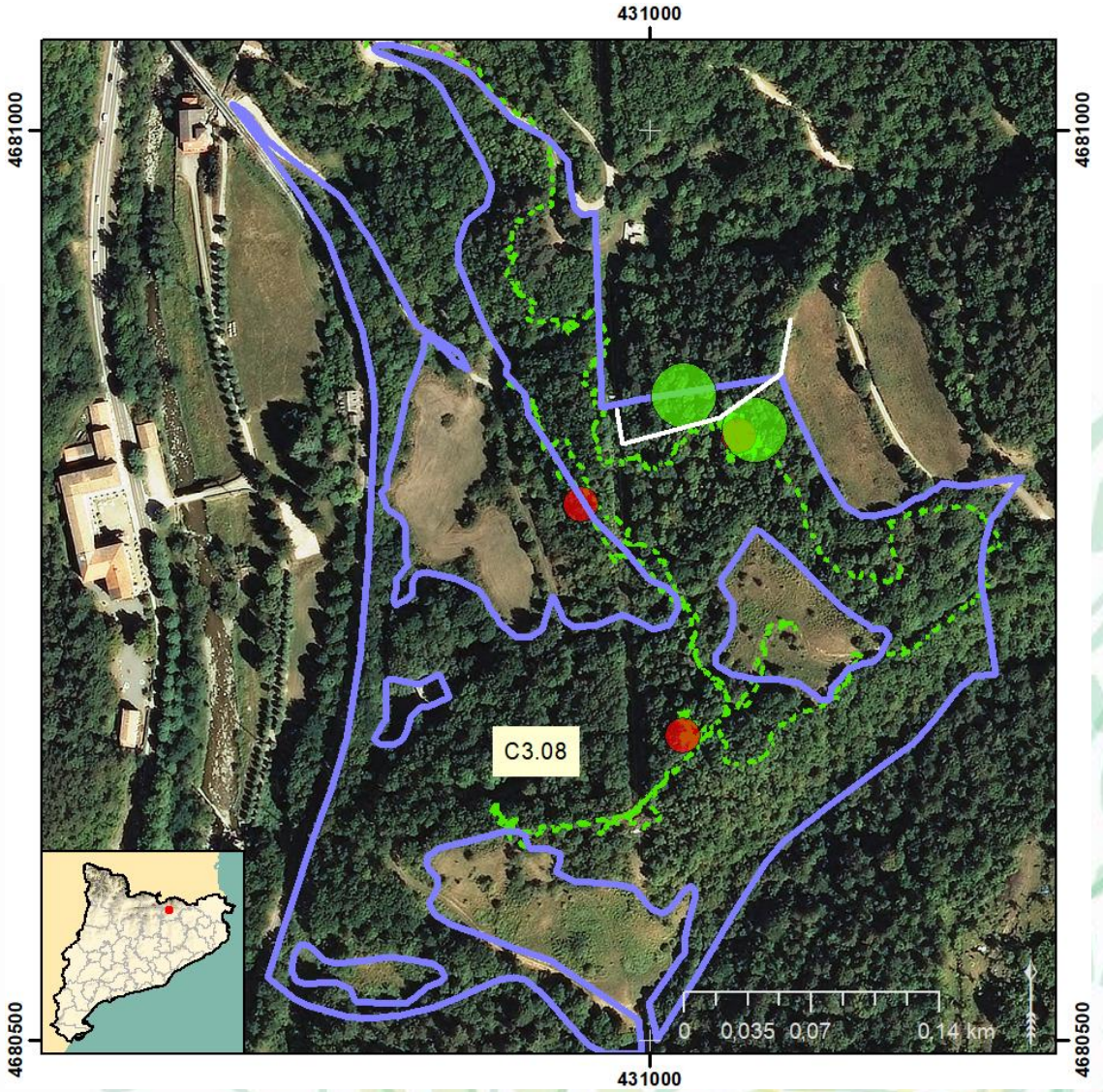
Interventions monitoring

Study area	Stand	Area (ha)	ECO	DASO
Montnegre - Corredor	C1.1	7,22	1+1	3
	C1.2	11,28	-	5
	C1.3	1,32	-	1
	C1.4	2,42	-	2
	C1.5	2,00	-	2
Montseny	C1.6	6,50	1+1	3
Montnegre - Corredor	C2.1	1,37	-	1
	C2.2	1,48	-	-
	C2.3	0,32	-	-
	C2.4	1,40	-	-
	C2.5	2,45	-	1
	C2.6	0,21	-	-
	C2.7	1,85	-	2
	C2.8	0,65	-	-
	C2.9	6,38	-	1
	C2.10	1,05	-	1
	C2.11	1,0	-	1
	C2.12	2,5	1+1	2
Montseny	C2.13	6,9	1+1	3
Montnegre - Corredor	C3.1	2,71	-	1
	C3.2	1,51	-	-
	C3.3	2,02	1+1	1
	C3.4	4,53	-	2
Bellmunt-Collsacabra	C3.5	8,46	-	3
	C3.6	23,84	1+1	6
Montseny	C3.7	7,50	1+1	3
Ripollès	C3.8	8,30	1+1	3
Montnegre - Corredor	C4.1	5,05	-	2
	C4.2	5,90	-	1
	C4.3	5,80	1+1	2
	C4.4	4,35	-	1
Bellmunt-Collsacabra	C4.5	16,09	1+1	6
Montseny	C4.6	6,20	1+1	3
Ripollès	C4.7	3,30	-	3



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Technical evaluation of the silviculture applied and lessons learnt

Marking

- Marking is essential (future crop trees and/or competitors)
- Define and transfer simple technical prescriptions, progressively and only to foreman
- They must be agreed with the technical staff and owners
- Describe instructions compared to baseline silviculture

- If possible, a full marking is done

- In poorly accessible sites: demonstrative marking to train forest workers; further monitoring required (BA control)

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Technical evaluation of the silviculture applied and lessons learnt

Future crop trees promotion

- Define characteristics of future crop trees
- Species identification (leafless trees)
- Crown release, keeping a service (sub-dominant) stratum

Particularities at species level

- Chestnut, oak: prudent releasae
- Oak: consider orientation (aspect)

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Technical evaluation of the silviculture applied and lessons learnt

Shrub clearing

- Insist on discontinuous + selectiveness
- Insist in the application of coppice with standards also in shrubs
- In areas with low tree density: apply clearing before tree cutting
- First days: intense supervision

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Technical evaluation of the silviculture applied and lessons learnt

Overall evaluation of MixForChange silviculture vs. baseline silviculture

- Higher investment in technical staff (especially: training), marking, clearing

- Lower investment in all other works (felling, skidding...)

- Economic balance: **similar** (lower income & lower costs)

- Better outcomes in terms of adaptation, conservation, future stand value

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CONCLUSIONS

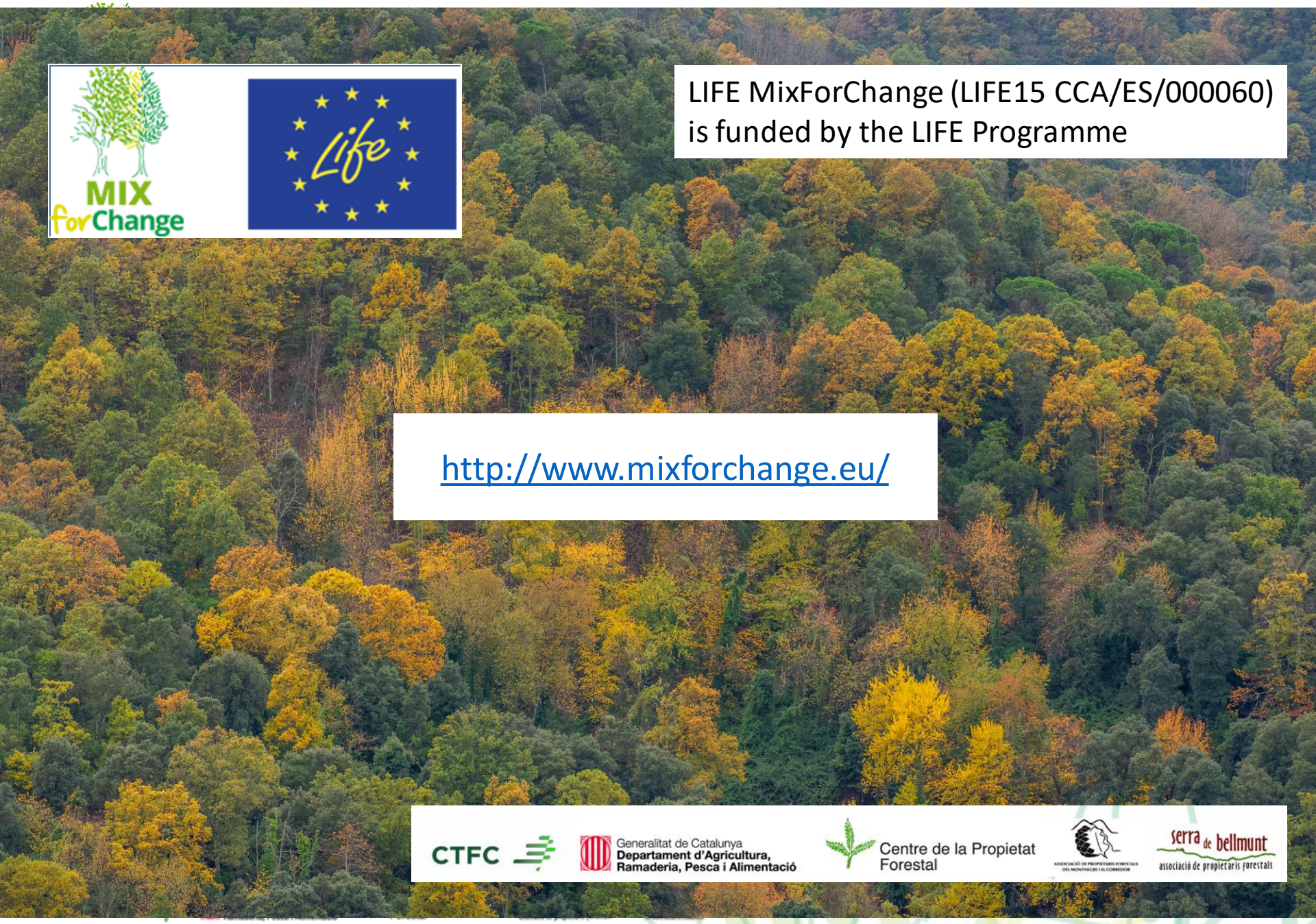
→ MixForChange silviculture: adaptive to CC + high conservation outcomes + increased economic potential without increasing management costs

→ This silviculture is complex to define, transfer and apply (species ecology, forests dynamics, silvicultural treatments, forest operations…)

→ Avoid fast changes; take the stand progressively toward more resilient structures

→ Tree marking + capacity building are essential (detailed interventions)

→ Interventions should focus on releasing future crop trees (crown level!)



LIFE MixForChange (LIFE15 CCA/ES/000060) is funded by the LIFE Programme

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