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## Management of genetic diversity: protected areas and dynamic in situ conservation of genetic resource

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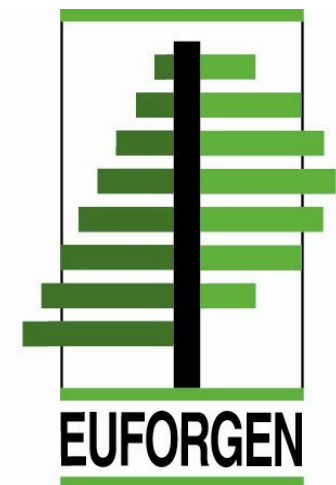
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# Management of genetic diversity: protected areas and dynamic *in situ* conservation of genetic resource



F. Lefèvre

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## 1) Importance of the genetic diversity regarding climate change

- Basic level of biodiversity determining the response of the ecosystem
- The concept of genetic resources (GR) and their values

## 2) Conservation of GR in theory : necessary dynamic approach

- Diversity means evolution
- Dynamic approach of conservation

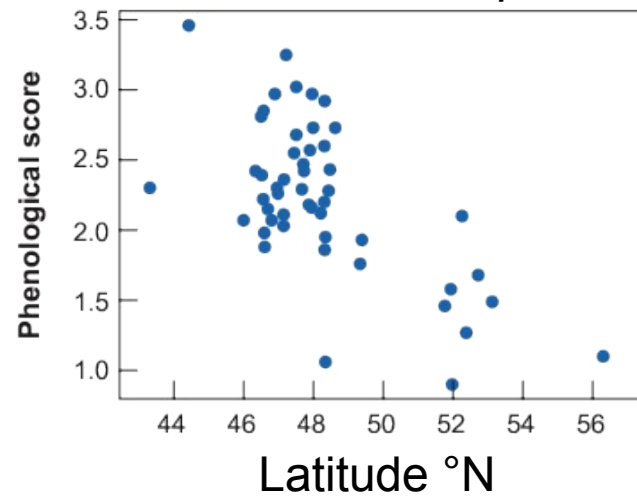
## 3) Conservation of GR in practice : the example of forest GR

- Case studies at national (France) and continental (Europe) scale
- Reconciliate GR conservation and protected areas systems

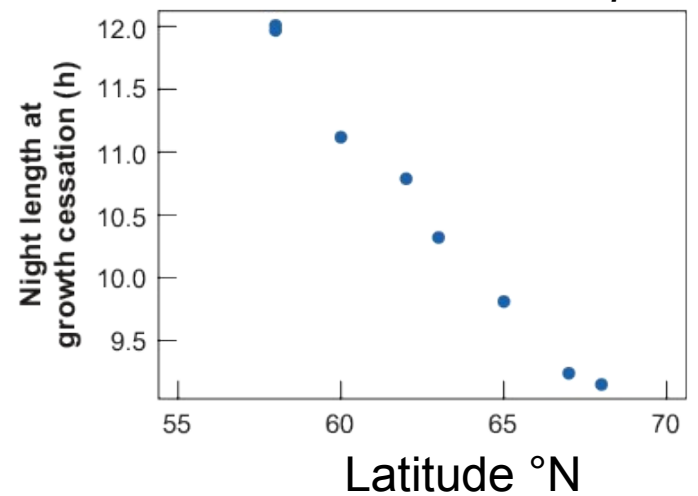
## 4) General recommendations

# The genetic diversity within species is huge

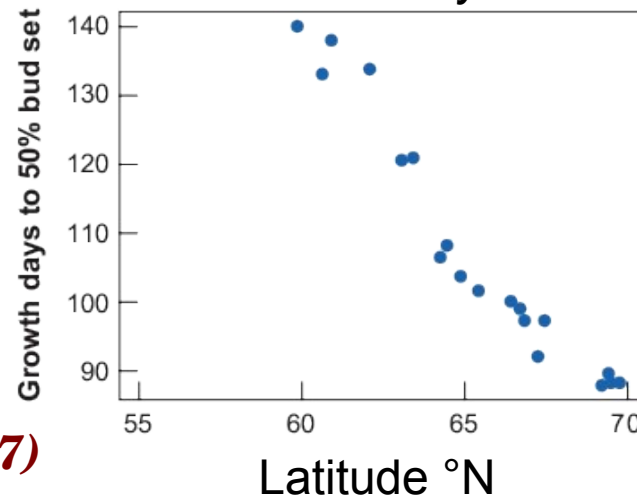
a Budburst *Quercus petraea*



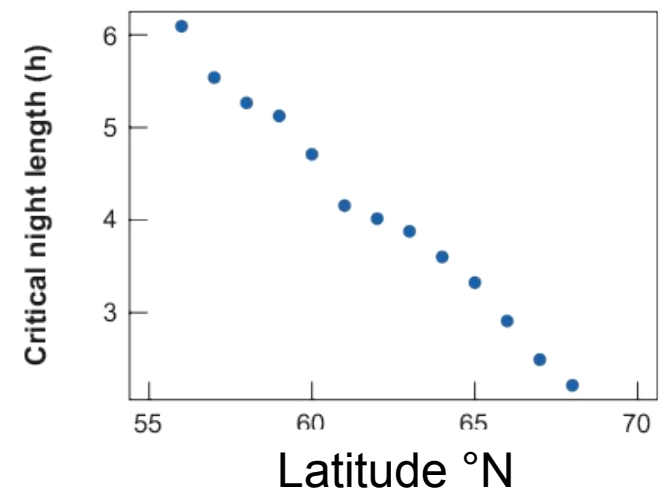
b Growth cessation *Betula pendula*



c Budset *Pinus sylvestris*



d Growth cessation *Picea abies*

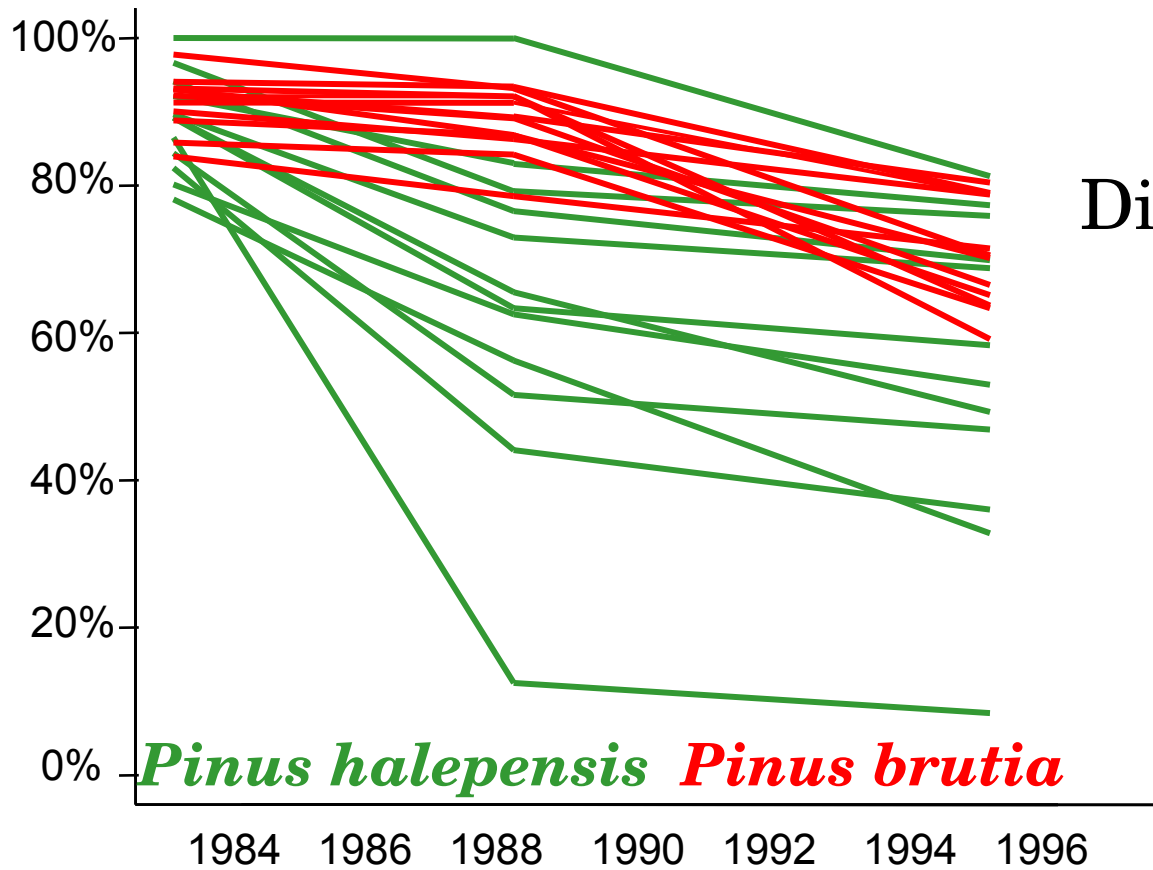


(Savolainen et al, 2007)



# The genetic diversity within species is huge

*Survival in 1 test site, 22 provenances (2 species)*



Diversity within species :

- between populations
- within populations

*(Pichot et al, 1998)*

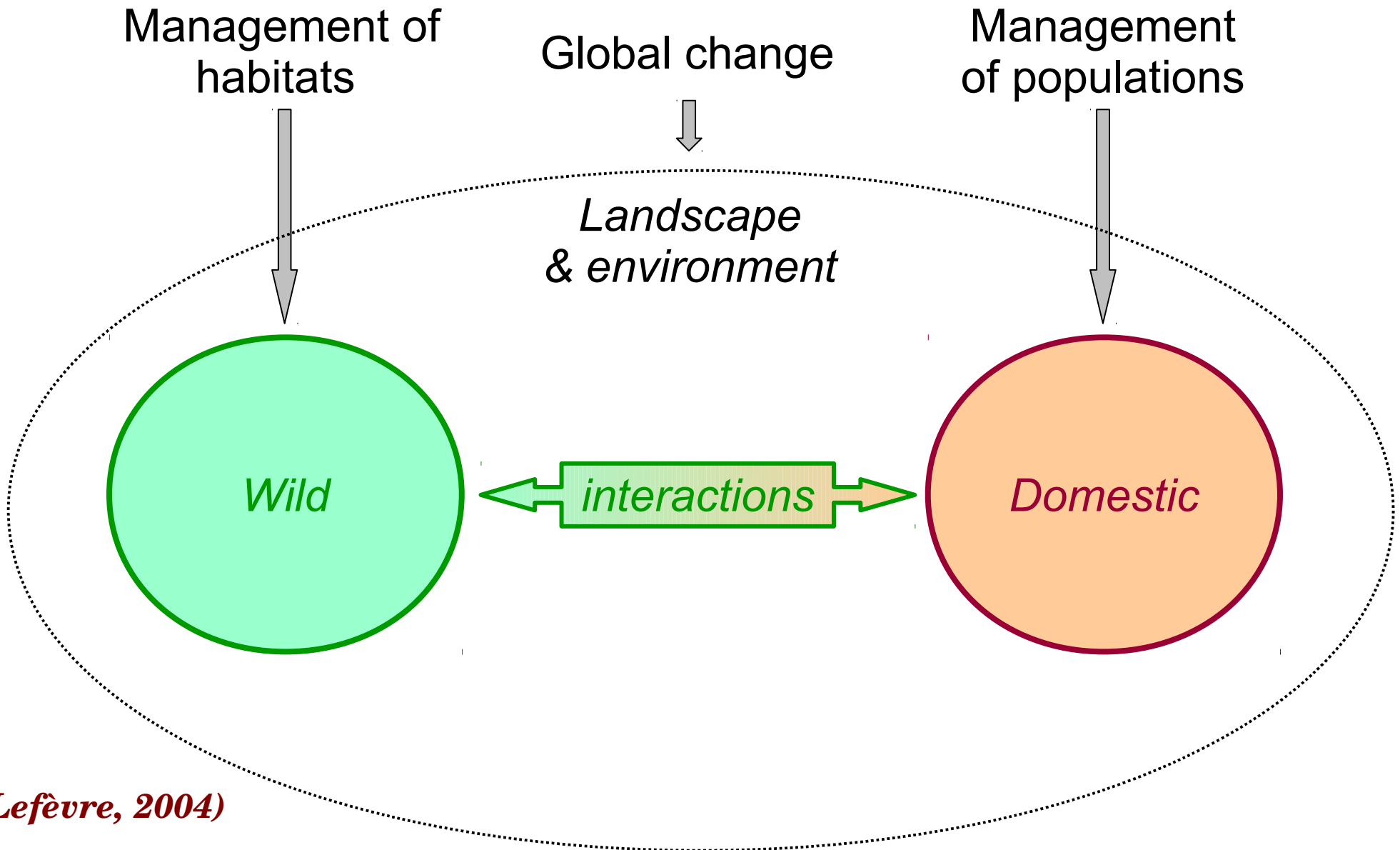
# The concept of genetic resources (GR)

GR means genetic material of **actual** or **potential value**.

*genetic material means any material of plant, animal, microbial or other origin containing functional units of heredity*



# The concept of genetic resources (GR)



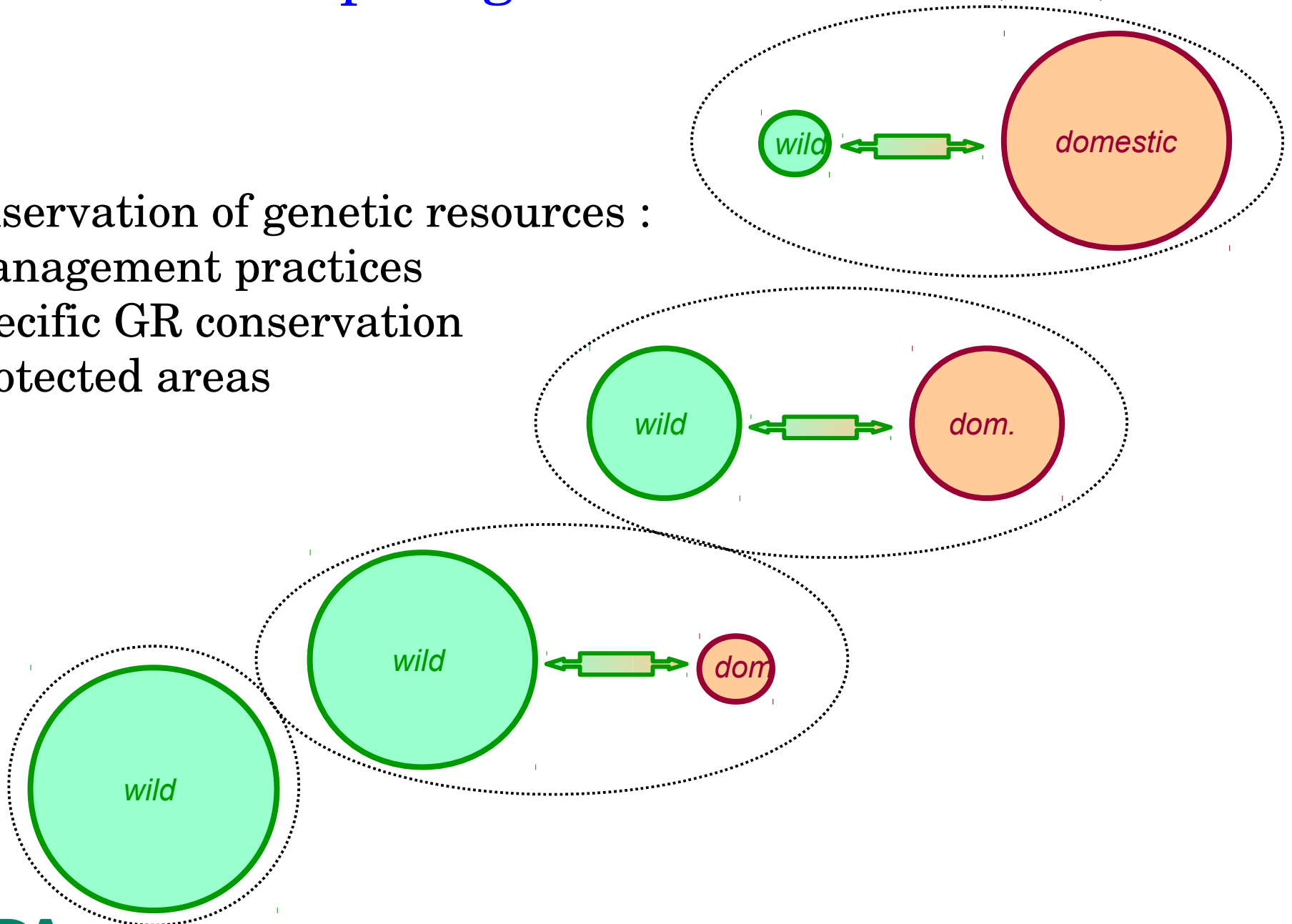
*(Lefèvre, 2004)*



# The concept of genetic resources (GR)

Conservation of genetic resources :

- management practices
- specific GR conservation
- protected areas



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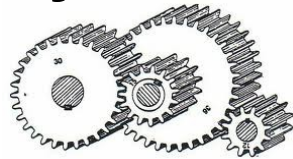
- Case studies at national (France) and continental (Europe) scale
- Reconciliate GR conservation and protected areas systems

## 4) General recommendations

# Diversity = evolution: the dynamics of adaptation

Relatives are *alike* but not *identical* : sexual reproduction continuously generates new genetic combinations

**Dynamics**



Genetic diversity is not fixed, genetic adaptation occurs if :

- (1) better performing genotypes emerge during reproduction
- (2) the best performing genotypes spread in the population before it goes extinct



# Diversity = evolution: the dynamics of adaptation

As the community evolves during maturation of the forest,  
the genetic diversity evolves across generations





# Diversity = evolution: the dynamics of adaptation

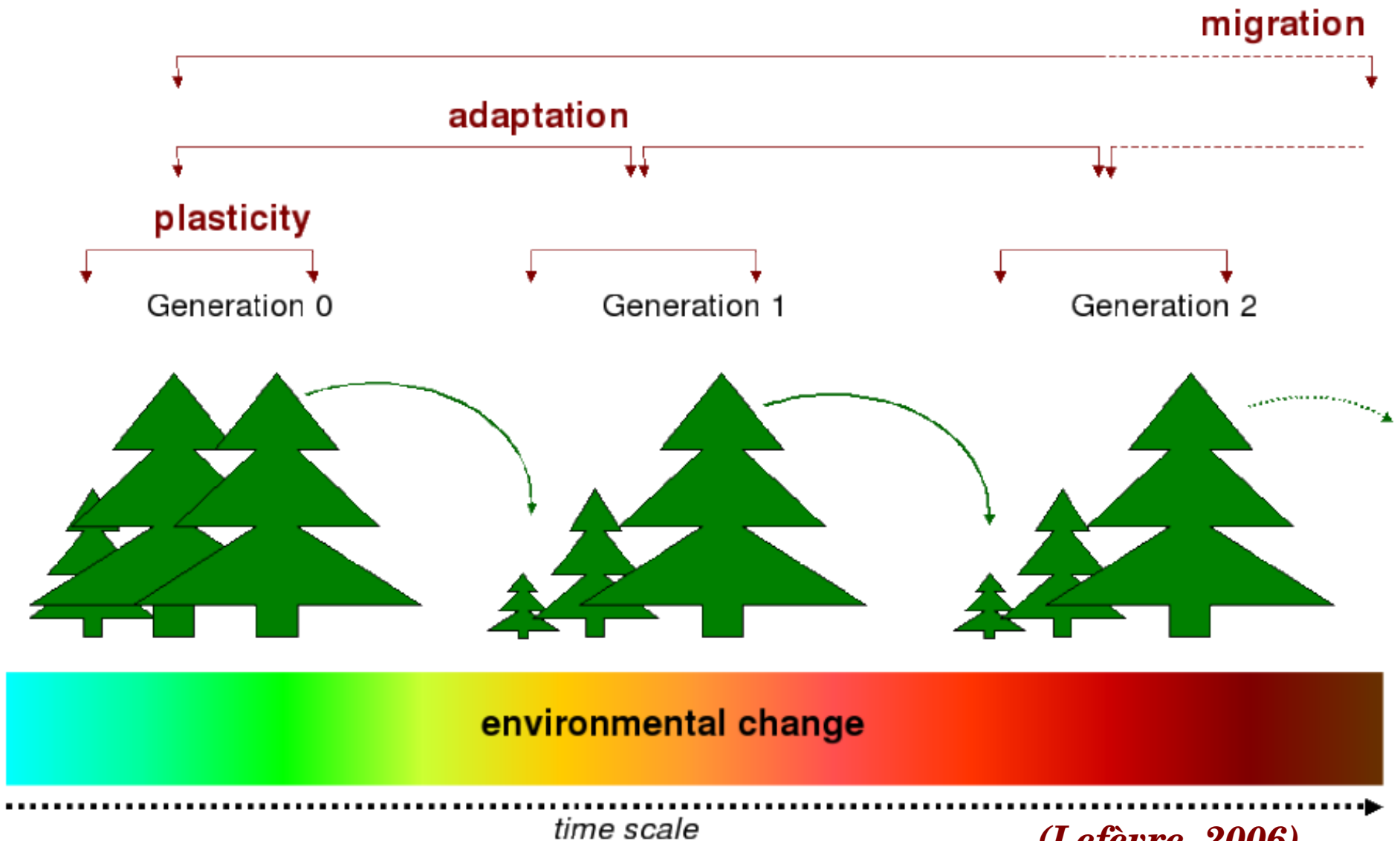
*Pinus radiata*, the most planted tree : enlarging its realised climatic niche thanks to plasticity and/or genetic evolution

Region	Annual rainfall (mm)	Tmean (°C) coldest month	Tmean (°C) warmest month
<b>California (5 pops)</b>	<b>420 – 700</b>	<b>10 – 11</b>	<b>16 – 18</b>
<i>N-Z (Southland)</i>	<b>960 – 1000</b>	<b>3 – 5</b>	<b>13 – 15</b>
<i>N-Z (Kaingaroa)</i>	<b>1300 – 1500</b>	<b>7 – 9</b>	11 – 19
<i>Chile (Valdivia)</i>	<b>2350</b>	<b>7.7</b>	17
<i>South Afr. (Cape)</i>	<b>900 – 1100</b>	10 – 13	<b>20 – 24</b>
<i>China (Sichuan)</i>	490 – 590	<b>-3.4 – -0.7</b>	<b>25 - 28</b>
<i>Aust. (Bathurst)</i>	650 – 950	<b>0.4 – 0.6</b>	<b>24 – 28</b>
<i>Aust. (Tumut)</i>	800 – 1300	<b>0.5 – 0.8</b>	<b>25 – 30</b>

*(Yan et al, 2006)*

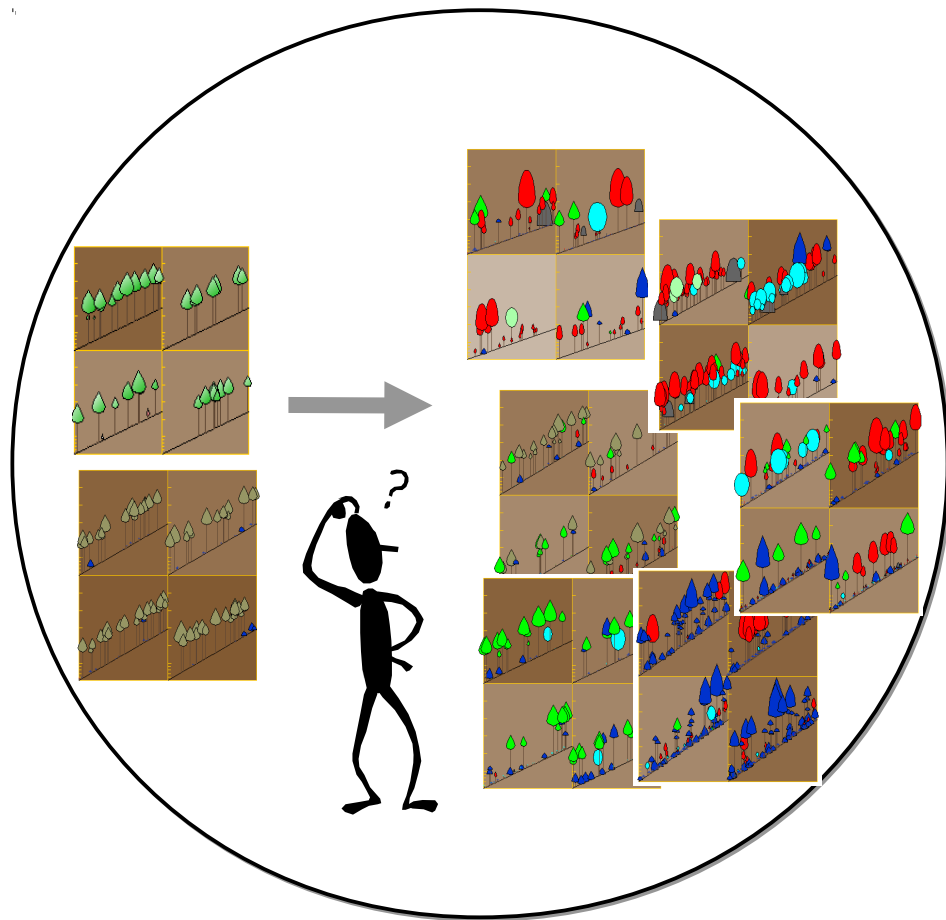
# Diversity = evolution: the dynamics of adaptation

A matter of velocity : velocity of changes vs. velocity of adaptation



(Lefèvre, 2006)

# A necessary dynamic approach of conservation



- Facing multiple uncertainties, 2 principles:
  - *preserve diversity*
  - *foster evolution*
- Think in trajectories rather than ideotype or steady state
- Avoid hasty decisions that reduce future options

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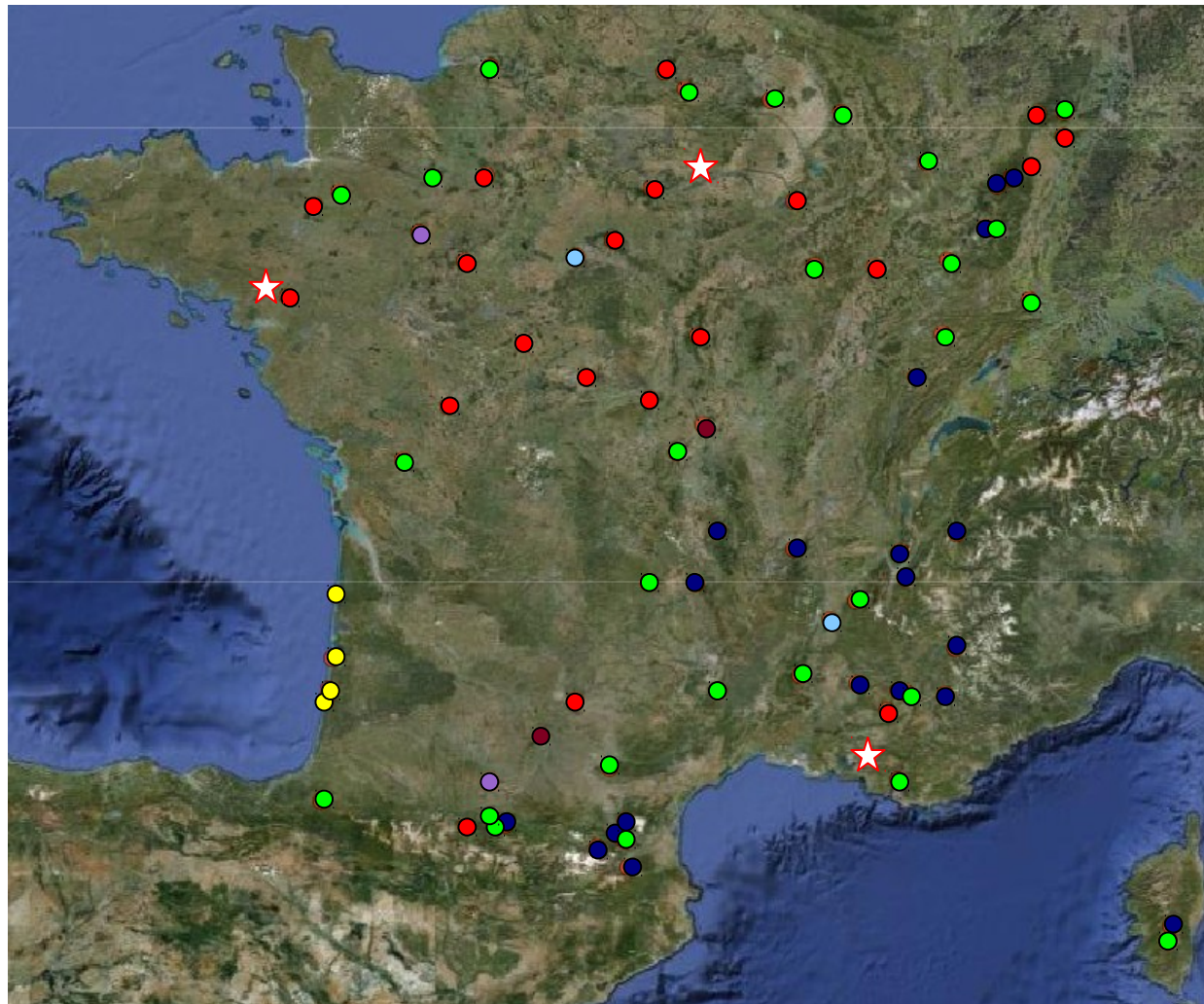
- Diversity means evolution
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## 4) General recommendations

# Conservation of forest genetic resources in France



● sessile oak  
● beech

● elm  
● wildcherry

● black poplar  
● maritime pine

● silver fir  
★ ex situ



Complementary  
*in situ* and *ex situ*  
strategies

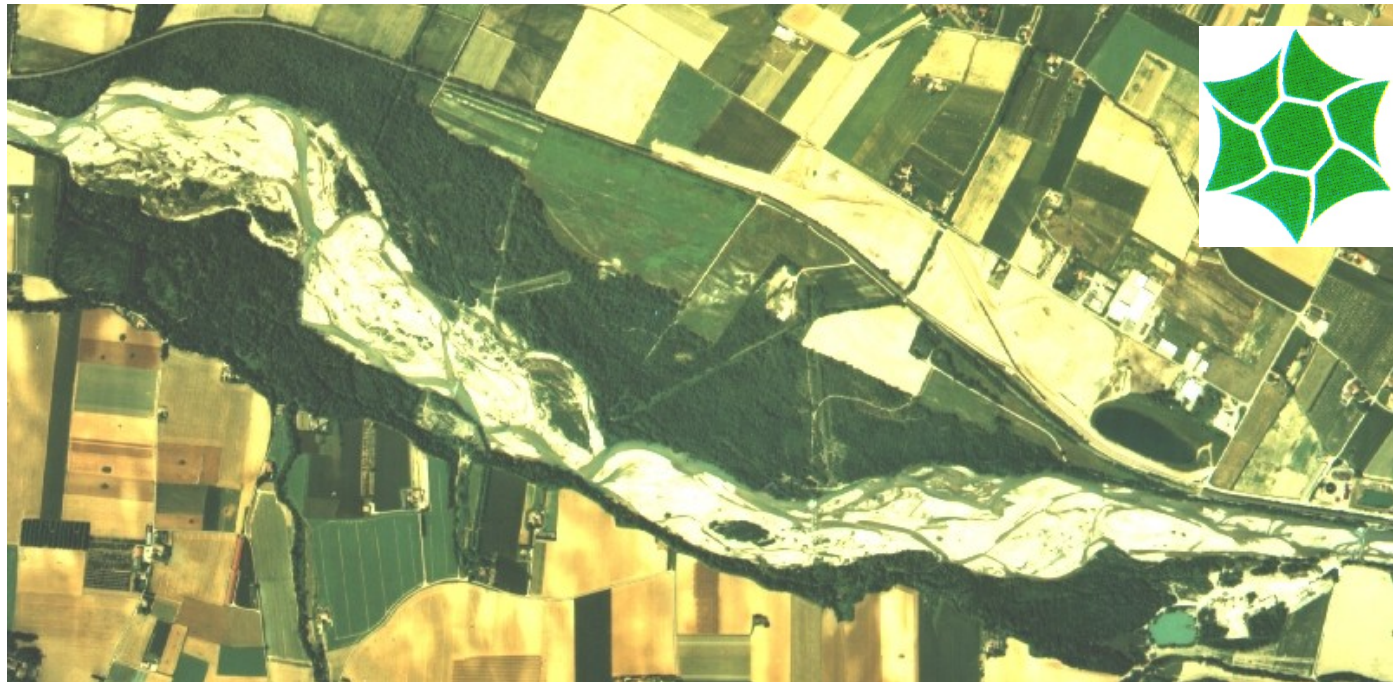
species-oriented  
approach

requirements for  
*in situ*  
conservation units



# Conservation of forest genetic resources in France

Involving protected areas in the FGR conservation network requires to investigate the complementarities and incompatibilities



Riparian Nature Reserves participate to the conservation of poplar and elm genetic resources



# Conservation of forest genetic resources in France

## National Strategy on Biodiversity : 7 actions on FGR

Stratégie nationale pour la biodiversité  
Rapport d'activité 2007

Ressources, territoires et habitats  
Énergie et climat Développement durable  
Prévention des risques Infrastructures, transports et mer

Présent pour l'avenir

Ministère de l'Écologie, de l'Énergie,  
du Développement durable et de l'Aménagement du territoire  
[www.developpement-durable.gouv.fr](http://www.developpement-durable.gouv.fr)

Plan d'action forêt  
2<sup>e</sup> période de programmation 2008/2010  
Stratégie nationale  
pour la biodiversité

Ressources, territoires et habitats  
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# Conservation of forest genetic resources in France

National Plan of Adaptation to CC : 1 flag action for the forests conserve, adapt and diversify FGR

Plan national

d'adaptation  
au CHANGEMENT CLIMATIQUE



MINISTÈRE  
DE L'AGRICULTURE  
ET DE LA PÊCHE

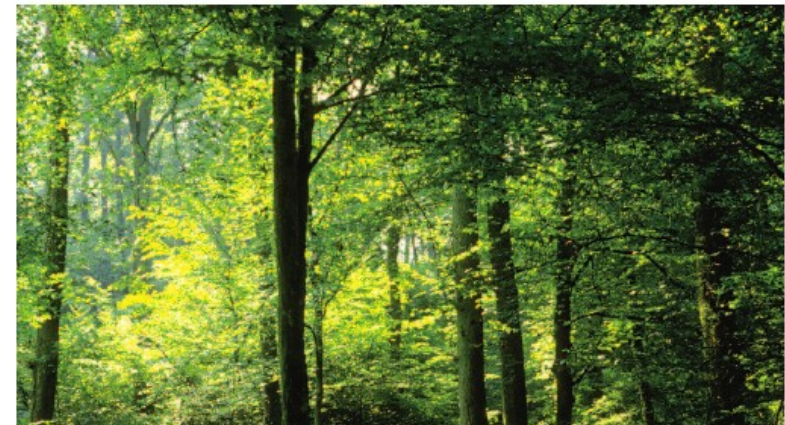
DGPAAT/SOUS-DIRECTION DE LA FORÊT ET DU BOIS

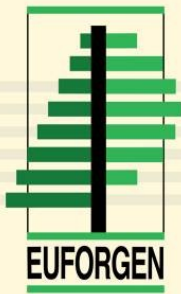
Commission on  
Forest  
Genetic  
Resources



**Preservation and use  
of the diversity of forest genetic resources  
to strengthen the adaptability  
of forests to climate change**

Genetic resources cover an area of biodiversity of actual or potential value. In forests, genetic diversity of trees is also a key factor which fosters general biodiversity of the ecosystem and interacts with its function. The diversity within species is not always easy to observe but it exists between and within populations of trees. Driven by the laws of genetics, it is dynamic, through seed and pollen





# European Forest Genetic Resources Programme

Jarkko Koskela

EUFORGEN Coordinator

Bioversity International, Regional Office for Europe, Rome

- A collaborative mechanism among countries to promote conservation and sustainable use of FGR in Europe
- Established in October 1994 to implement a resolution of the pan-European forest policy process (Ministerial Conference on the Protection of Forests in Europe)
  - Resolution S2: Conservation of forest genetic resources, Strasbourg Conference, 1990
  - Resolution V4: Conserving and enhancing forest biological diversity in Europe, Vienna, 2003
  - Warsaw Declaration, 2007



# Conservation of forest genetic resources in Europe

EUFGIS : information system on dynamic conservation of FGR at continental scale based on minimum requirements and standards

*(Koskela et al, Biol. Cons. in press)*

[www.eufgis.org](http://www.eufgis.org)

## Literature review

- Genetic diversity and related processes
- Dynamic conservation of genetic diversity
- Sampling for genetic conservation
- Forest management
- Monitoring

## European Forest Genetic Resources Programme

- Requirements for genetic conservation units of different tree species (conifers, scattered broadleaves and standing-forming broadleaves)
- Conservation guidelines
- Descriptors for inventories of FGR

## National programmes on forest genetic resources (FGR)

- National policies and practices
- Survey on FGR conservation in 31 countries
- Workshop on FGR conservation and documentation in Europe

**Pan-European minimum requirements for dynamic conservation units of forest tree genetic diversity**

EUFGIS expert meetings (3)

EUFGIS pilot testing (Austria, Denmark, France, Slovakia, Slovenia and UK)

# Conservation of forest genetic resources in Europe

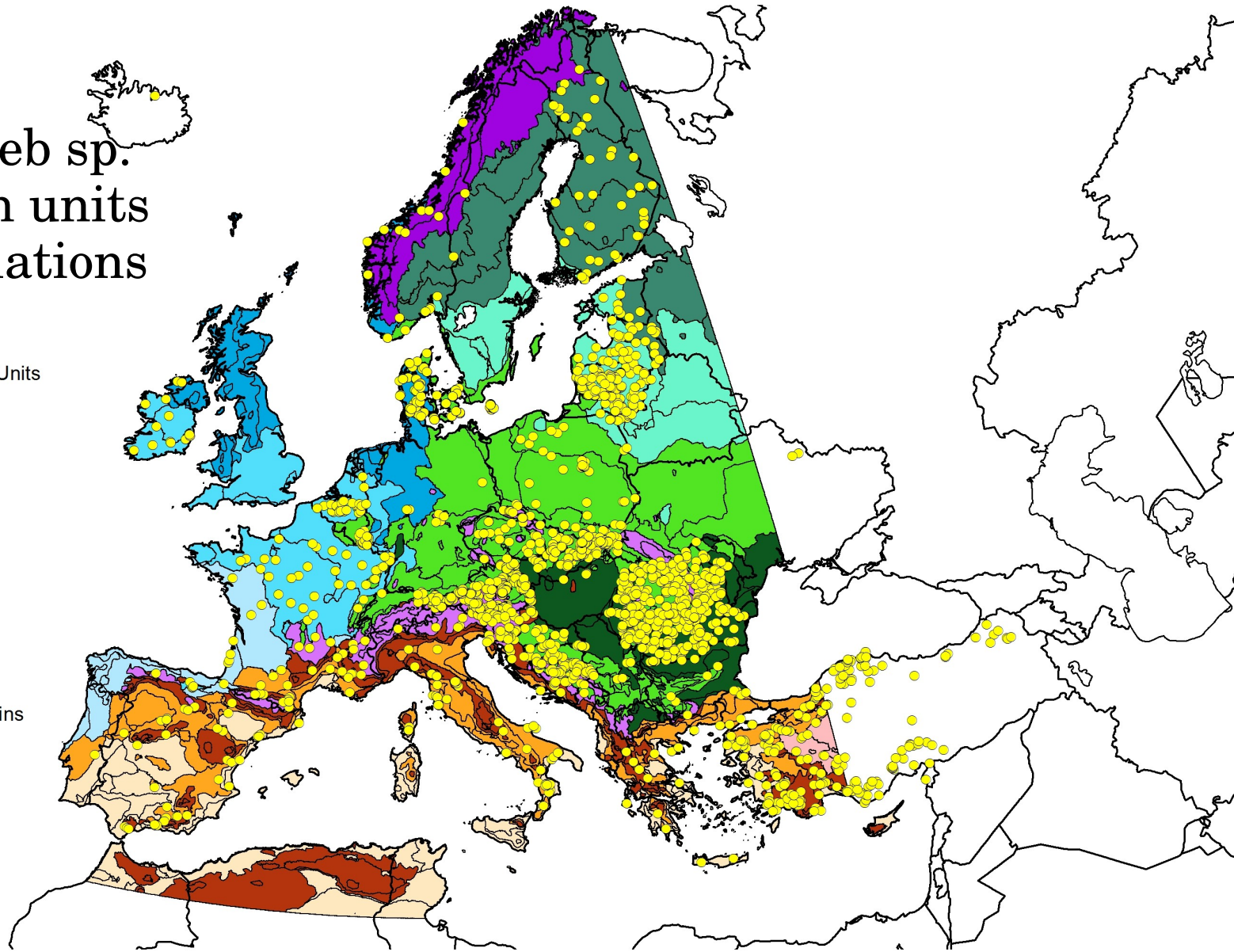
33 countries  
86 indigenous tree sp.  
1967 conservation units  
2737 target populations

## Environmental Zones

● Genetic Conservation Units

- Alpine North
- Alpine South
- Anatolian
- Atlantic Central
- Atlantic North
- Boreal
- Continental
- Lusitanian
- Mediterranean Mountains
- Mediterranean North
- Mediterranean South
- Nemoral
- Pannonian

0 125 250 500 750 1,000 Km

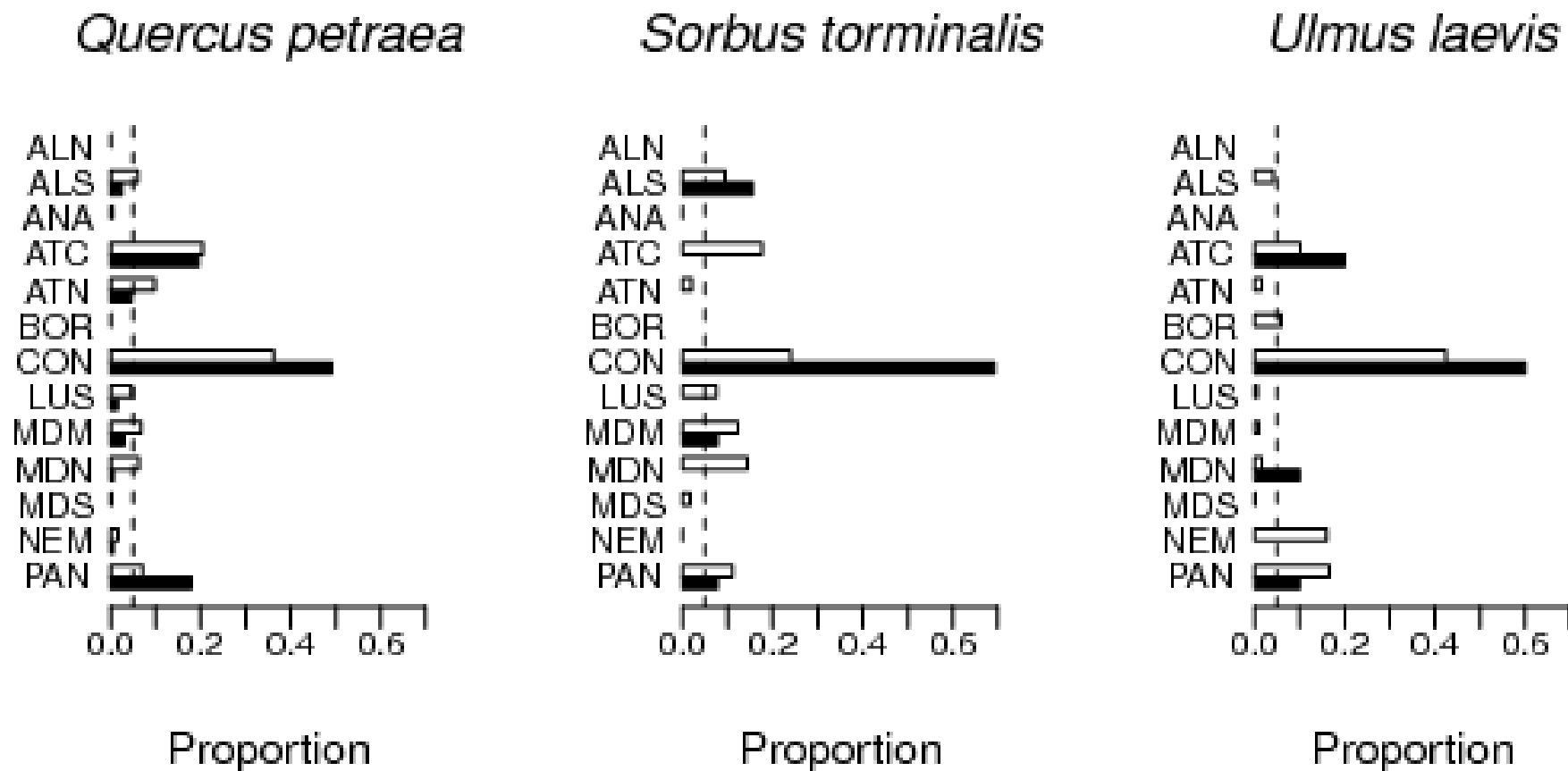


*(Lefèvre et al, Cons. Biol. in press ; envir. zones by Metzger et al, 2005)*



# Conservation of forest genetic resources in Europe

Indicators of the environmental coverage of the FGR network



(Lefèvre et al, Cons. Biol. in press ; envir. zones by Metzger et al, 2005)

# Conservation of forest genetic resources in Europe

Management objectives other than FGR conservation assigned to the conservation units:

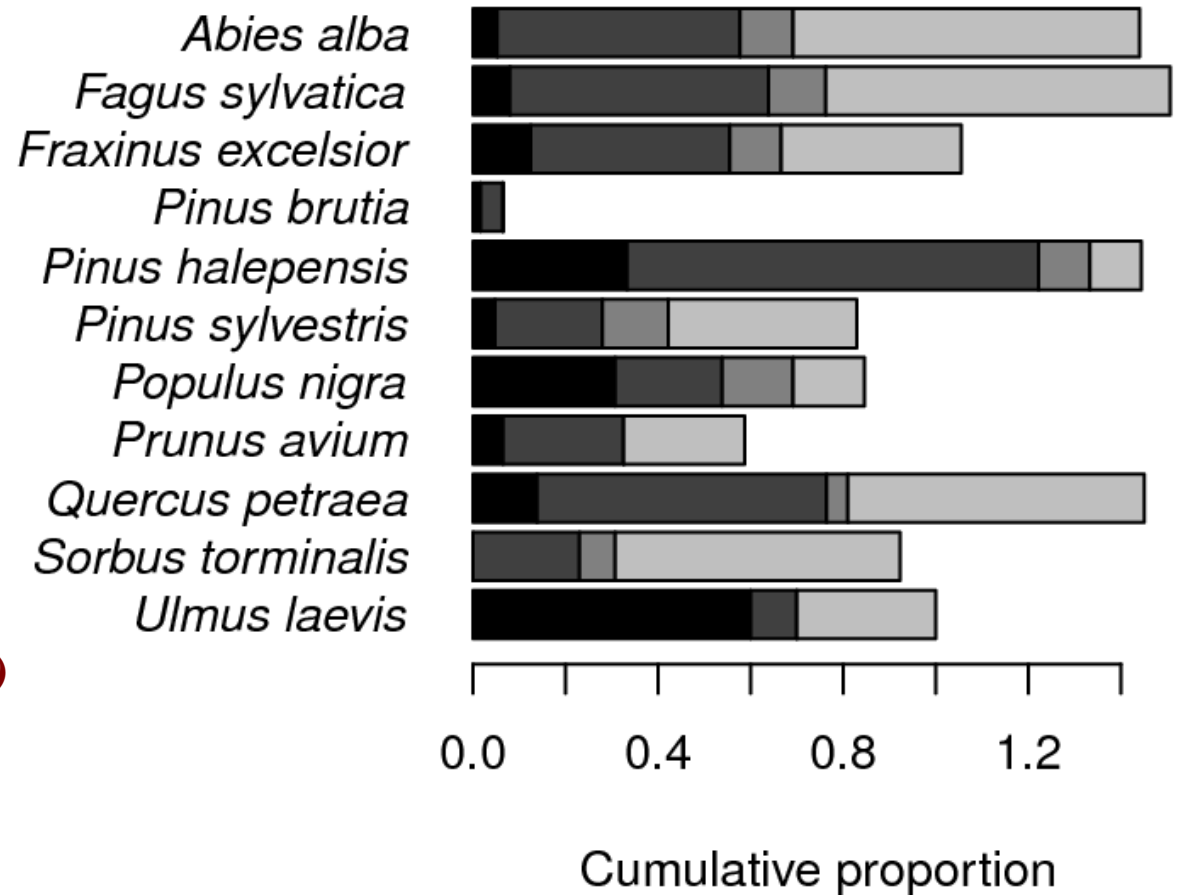
little connection between FGR conservation and protected areas

■ **conservation of habitat**

■ forestry seed production

■ protection area

■ wood production



(Lefèvre et al, Cons. Biol. in press)

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## 4) General recommendations

# General recommendations

1. conserve the genetic diversity to keep a range of options for uncertain future and various regional scenarios,
2. give priority to dynamic conservation strategies because the genetic diversity changes continuously, partly driven by management and landscape planning,
3. develop and reinforce the conservation networks of genetic resources at national and continental scale ; standardize surveys and improve the monitoring process.
4. include the conservation of genetic resource as an objective in protected areas whenever compatible based on minimum requirements and standards.