Testing tree species adapted to future climates: a test case for adaptive management

Tester des essences adaptées aux climats futurs : modèle d’une gestion adaptative

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500 - 700 m

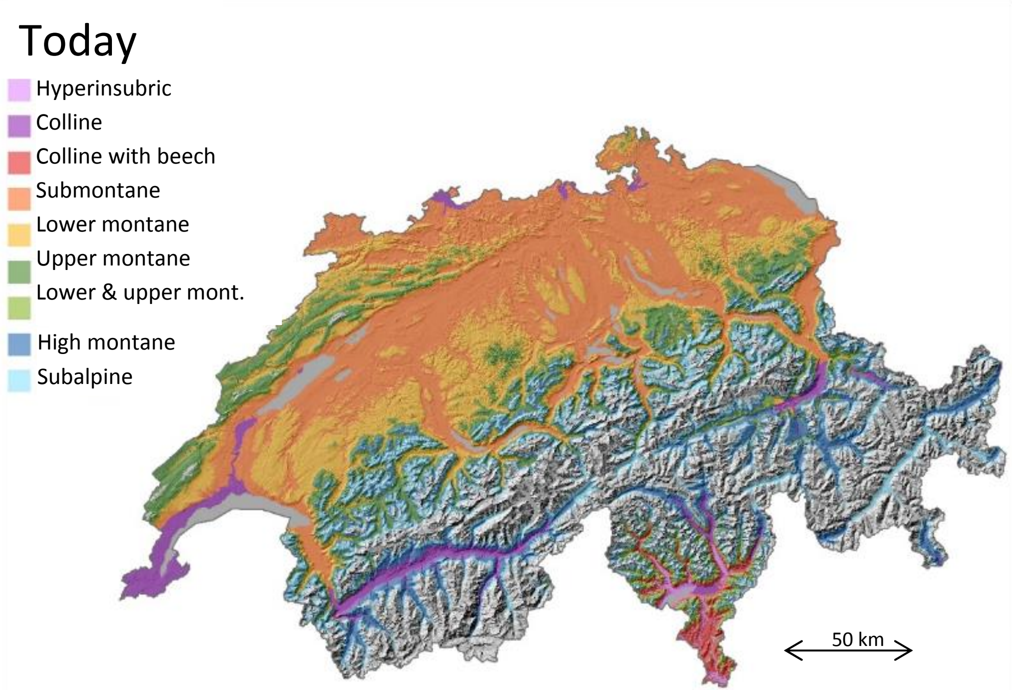
Evidence and need for tree species shifts

- Adaptation by a gradual change of tree species composition:
  A main conclusion of the research program ‘Forests and climate change’, 2009-2017, with >50 projects (*synthesis book on display*)
- *Modeled* shifts for >30 tree species, based on climate envelopes
- *Modeled* shifts of altitudinal belts
- Small *observed* shifts and local species-specific mortality
- Tree species shifts require time (stand regeneration phase) – start now, given the long generation cycles

Drawing: A. B. Nielsen

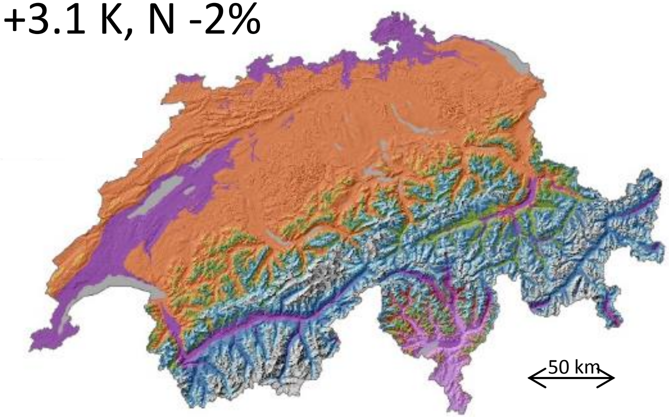
Shifting altitudinal belts

Today vs. predicted 2070-2099, using 2 models within the A1B emission scenario

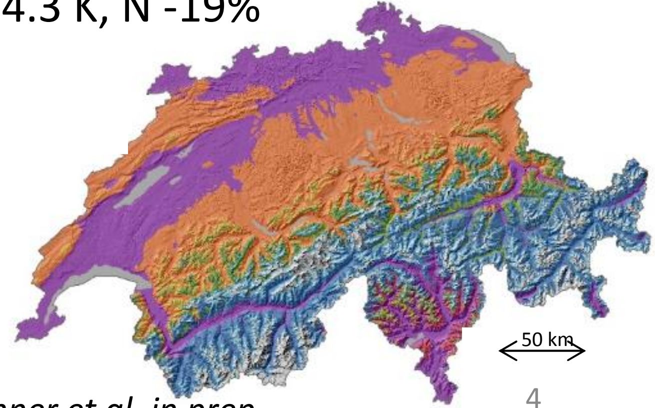


2070 - 2099

Climate projection RegCM3
T +3.1 K, N -2%



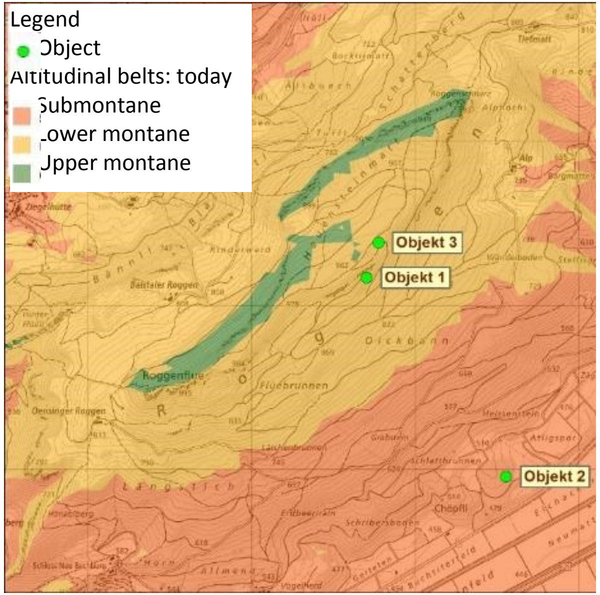
Climate projection CLM
T +4.3 K, N -19%



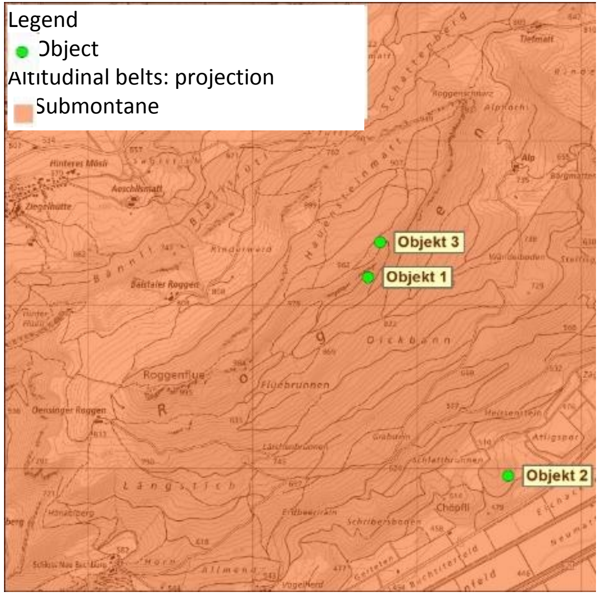
Frehner et al. in prep.

Shifting altitudinal belts – example Oberbuchsiten (Jura mountains)

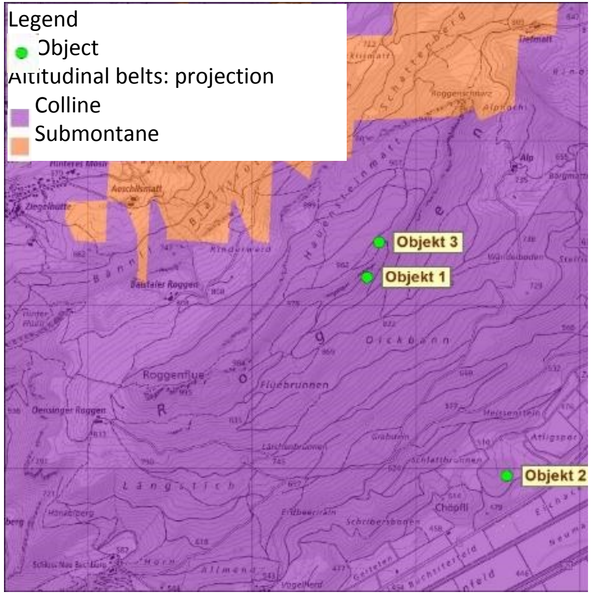
Today



Model RegCM3 2070 - 2099



Model CLM 2070 - 2099



1 km

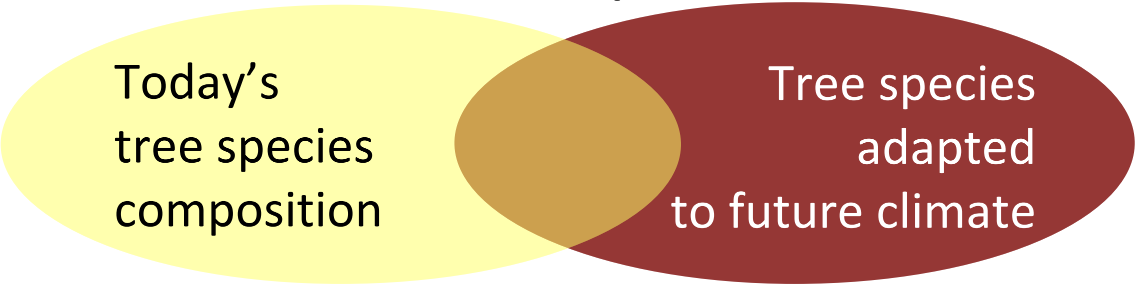
Frehner et al. in prep.

Change of altitudinal belt → change of forest association → change of suitable tree species

Today *Lower montane belt*	**RegCM3 2070-2099** *Submontane belt*	**CLM 2070-2099** *Colline belt*
12a *Cardamino-Fagetum typicum*	**9a** *Pulmonario-Fagetum typicum*	**35** *Galio silvatici-Carpinetum*
Dominant tree species: *Fagus sylvatica*	Dominant tree species: *Fagus silvatica*	Dominant tree species: *Carpinus betulus, Quercus petraea*
Admixed tree species: *Abies alba, Acer pseudoplatanus, Fraxinus excelsior, Ulmus glabra*	Admixed tree species: *Acer pseudoplatanus, Fraxinus excelsior, Prunus avium, Quercus petraea*	Admixed tree species: *Acer campestre, Acer opalus, Pinus sylvestris, Prunus avium, Sorbus aria, Sorbus torminalis, Tilia platyphyllos*
Dominant height: 30 – 35 m	Dominant height: 25 – 35 m	Dominant height: 25 – 35 m

Frehner et al. in prep.

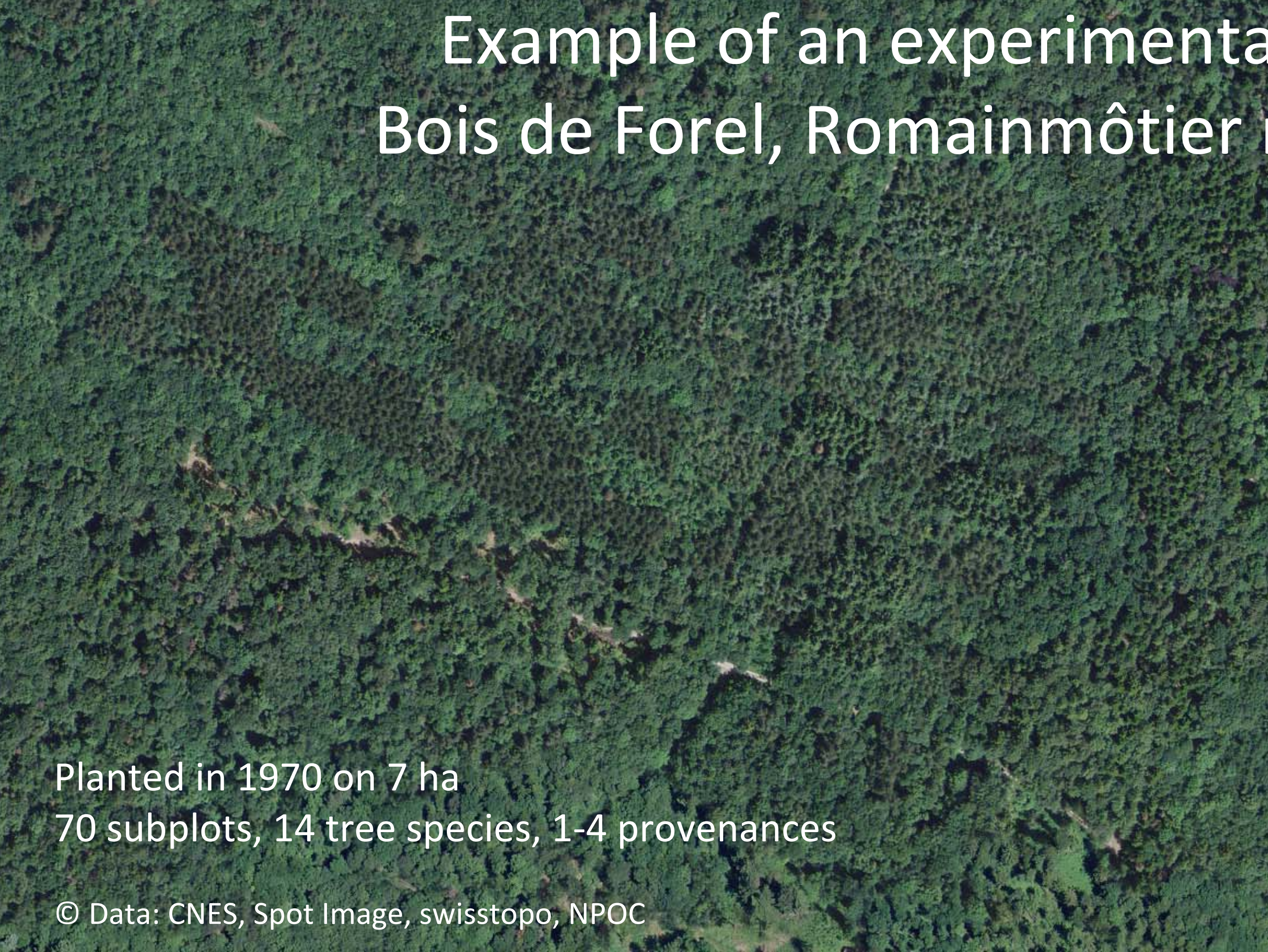
Project ‘Testing tree species adapted to future climates’
- research question



How do species that seem suitable on a given site
at the end of the 21st century perform if planted now,
and what are the limiting factors?

→ Network of experimental plantations

Example of an experimental plantation: Bois de Forel, Romainmôtier near Geneva

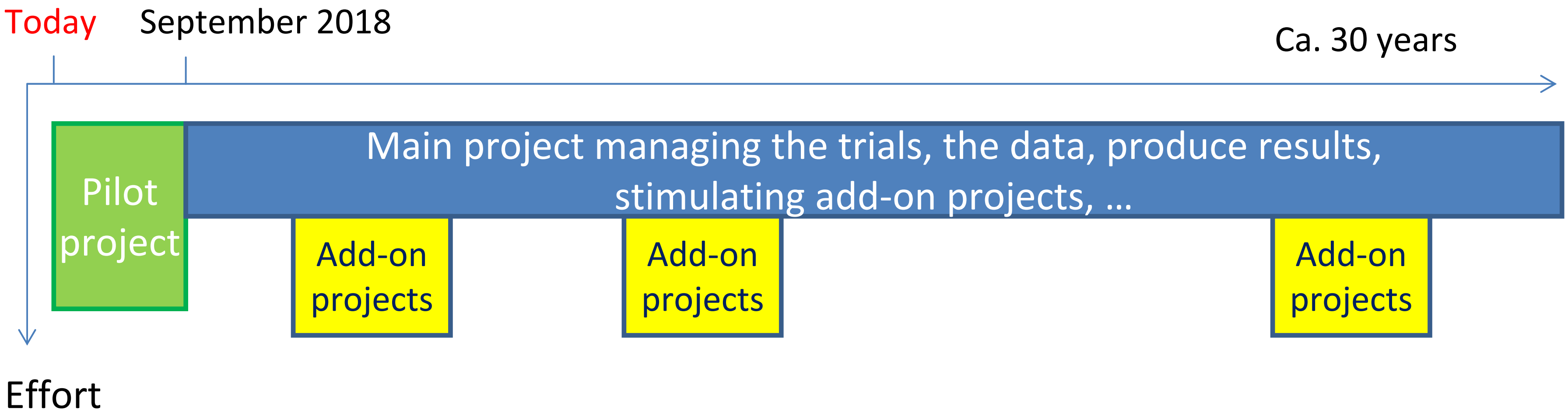


Planted in 1970 on 7 ha
70 subplots, 14 tree species, 1-4 provenances

Framework of the project

- Natural regeneration is the preferred regeneration method in Switzerland
- Foresters have expressed a need for coordinated test plantations
- Creation of a long-term infrastructure (expensive, need for supervision: deer-proof fences on partly steep slopes) → research-practice cooperation, with researchers having a consultancy and coordination role
- Opportunity for adaptive management ('targeted learning by doing')

Testing tree species adapted to future climates: timeline



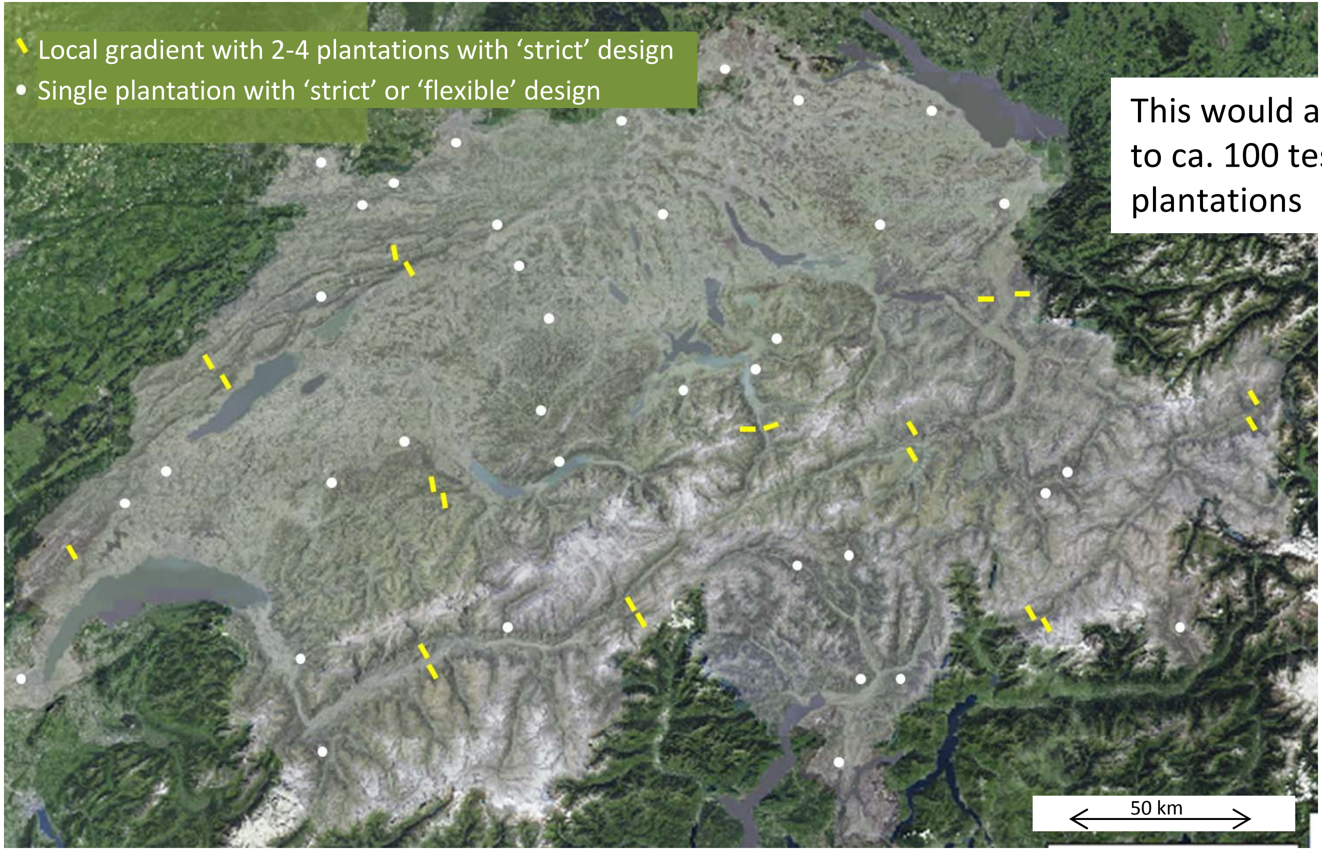
Project pilot phase

	2017				2018	
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q
Trial design	1st work-shop	Development of alternative trial designs	Scientific workshop to evaluate the design	Decision on trial design	Measure-ment protocol	Database
Communi-cation		Forest services & nurseries are informed Website online	Workshop with stakeholders Inventory of existing test plantations Cantons report potential trial sites		Provenance selection & start of plant acquisition	
Realisation			Visit of existing plantations	Site evalua-tion starts	Site assess-ment starts	First test plantation established

Trial design – first ideas

- Test plantations with 'flexible' and 'strict' design
- 'Flexible' design:
  - integrates many needs/wishes of participating foresters, weak standard
  - focus on success/failure and not on causes ('*simple but meaningful*')
- 'Strict' design:
  - Should ensure scientific inference and understanding
  - Set of tree species and provenances defined
  - 20-50 test plantations per tree species
  - Test plantations on local environmental *gradients* (where possible)
  - Cover large gradients (from assumed good performance to severe mortality)

Visualisation of a potential distribution of test plantations in Switzerland



This would amount to ca. 100 test plantations

Trials in the ‘strict’ design – number of seedlings

of seedlings depends on:

•# of tree species (5-10)

•# of provenances for each species (1-6)

•# of test plantations per tree species/provenance (20-50)

•# of replicates (subplots) per tree species/provenance within each plantation (1-3)

•# of seedlings within each subplot (10-50)

Decisions to be made – 5’000 to 50’000 seedlings seem manageable

Design concept – data catalog and campaigns

- Once: assessment of site characteristics: soil data, forest type, …
- Climate parameters modeled, measured only if needed
- Yearly in spring: mortality
- Yearly or every 2nd year (beginning): vitality, tree height, stem base diameter/dbh, damage (only in ‘strict’ design’)
- In a subset of the plantations with ‘strict’ design, additional parameters are assessed to allow for deeper analysis

Questions to the audience

1. Learning from similar efforts (REINFFORCE, …) – dos and don'ts
   a. Design
      1. Potential for analysis / getting relevant answers?
      2. Species & provenances: #, selection?
      3. Replication (within and between sites)?
      4. Advantages and drawbacks of the 2-design approach ('strict', 'flexible')?
      5. Small spacing and/or replacement planting to compensate early mortality?
   b. Management
      6. To what degree can forestry staff help in assessing data?
      7. How to minimize the risk of failure for whole plantations?

2. Potential for transnational cooperation
   a. Which similar approaches are underway?
   b. Interest in transnational efforts to increase knowledge gain ?


Merci !

Additional material: Potential species list

Strict design	Flexible design
Abies alba	Abies grandis
Fagus sylvatica	Corylus colurna
Quercus petraea	Juglans nigra
Prunus avium	Acer opalus
Juglans regia	Picea abies (provenances from dry margin)
Tilia cordata	Sorbus torminalis
Acer platanoides	