Utilizing assisted translocation to enhance forest growth and carbon stocks in European forests

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Climate change and European Forests

**Change in species composition**
- Decrease in share of conifers such as Norway spruce
- Increase in share of broadleaved species such as oaks

**Change in forest productivity**
- Increase in productivity in north and boreal region
- Decrease or constant in Mediterranean and central Europe
- High uncertainty in predicted changes

**Changes in disturbances**
- Increase in wind disturbances
- Increase in fire risk
- Rise in favorable conditions in pests and pathogens

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Climate change will alter link to local adaptation
This will result in maladapted populations

Hanewinkel et al 2012, Nat CC

Climate change and European Forests

- Migration
- Adaptation
- Extinction

Natural processes are too slow !!!
Our Action plan

• Recent European policy initiatives such as the EU Biodiversity Strategy, the 3 billion tree pledge calls for tremendous restoration efforts

• A large part will come from active plantation in addition to conserving existing forests.

• On a practical scale two questions become important
  • Which species to plant?
  • Where should I get adapted seeds and planting materials from?
Assisted migration

- Beyond range
- Within range

Map showing the distribution of species ranges across Europe, with arrows indicating migration paths and temperature and precipitation data.
Provenance trials

Sitka spruce planted in Vancouver

© Aitkin and Bemmels 2015
Harmonized provenance trial data (SUSTREE project)

- 575 Trials
- 10646 Provenances
- Wide range of site conditions
Suitable Species

(A) Current

(B) RCP8.5 2061-2080

- A alba
- P abies
- P sylvestris
- L decidua
- F sylvatica
- Q petraea
- Q robur
Universal Response Function

Above Ground Carbon = \( f(\text{climate of planting location} + \text{climate of seed origin}) \)
Assisted migration scenario

**Species choice**
- Species Today
- Species Future

**Seed source-choice**
- Local seeds
- Future adapted

**Carbon stocks**
- Adapted
- Local
- Adapted
Impact of forest adaptation strategies on carbon sequestration

Comparing:
Carbon sequestration under assisted migration

Carbon sequestration by local seed sources

Annual Carbon Sequestration of reforested forest stands (up to age of 40) in Million Tonnes or Terragram in above ground living biomass
Relevance for Europe’s emission targets

- Average annual CO$_2$eq (1991-2010 = 4294 Mt CO$_2$
- Proposed a target to expand the EU’s sink to absorb 310 million CO$_2$e per year by 2030
- 55% by 2030
- Carbon neutral by 2050
Impact of forest adaptation strategies on carbon sequestration

Comparing:
- Carbon sequestration under assisted migration
- Carbon sequestration by local seed sources

<table>
<thead>
<tr>
<th>Adapted Sources</th>
<th>Local Sources</th>
<th>RCP85(2061-80)</th>
<th>RCP45(2061-80)</th>
<th>Current</th>
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<tr>
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<td>Abies alba</td>
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<td>54 TG</td>
<td>67 TG</td>
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<td>Picea abies</td>
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- Annual Carbon Sequestration of reforested forest stands (up to age of 40) in Million Tonnes or Terragram in above ground living biomass

- = 168 TG CO₂/yr
- = 54 % of EU annual target of 310 TG CO₂
- = 92 TG CO₂/yr
- = 29 % of EU annual target of 310 TG CO₂
Conclusions

• Assisted migration/gene flow is able to sequester significantly more carbon even under strong warming (RCP8.5) and forest management for increasing resilience.

• Risks of Assisted migration such as invasiveness, hybridization, economic

• Tradeoffs between phenotypic traits

• Uncertainty in future
Our Tools

- **seed4forest**

- **baumartenampel**

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**High resolution climate data**

High-resolution gridded climate data for Europe based on bias-corrected EURO-CORDEX: The ECLIPS dataset

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Thanks for your attention

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