Quantifying invasiveness of Douglas fir on the basis of natural regeneration in southwestern Germany

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Douglas fir – *Pseudotsuga menziesii* (Mirb.) Franco

- *one of the most commercially significant tree species of non-native origin in the State of Baden-Württemberg Germany*

  State forest:
  
  40,000 m³ timber
  
  €4 million value
  
  average/year

- *importance expected to increase due to climate change*

Douglas fir in the city forest of Freiburg, State of Baden-Württemberg (photo: L. Vitkova)
Controversial discussions on the species’ status

**Nehring et al. 2003**

Non-native invasive tree species in Germany based on its dominance on rocky locations and acidophilous sessile oak forest sites.

**Spellmann et al. 2015**

Tree species cannot be invasive because of its regeneration ecology and controllability of its expansion.

Different criteria used for the assessment of invasiveness.
Assessment of invasiveness

- Lack of empirical-scientific data
- Expert opinions or small case studies
- No agreed consistent approach in European countries

Assessment of invasiveness often not sound-evidence based, replicable and transparent

**Aim**
Case study based on available quantitative data for evaluating the potential of Douglas fir to be or become invasive in a specific area
Case study Douglas fir

- Risk protocols: criteria matching main stages of invasion

Entry → establishment → potential for spread → adverse impacts

Our research aim
assess the current potential of Douglas fir to naturally regenerate in specific forest habitats

Data
currently available data on natural regeneration of Douglas fir derived from different inventory systems

Study area
State of Baden-Württemberg
38% forest cover

Provide an improved basis for the assessment of invasiveness of Douglas fir, thus, for identification of appropriate management approaches
Inventory data sets

1. German National Forest Inventory

- data on the state of the forests

- 2 x 2 km grid, covering 1.3 Mio ha forest

- Forest stand type: dominant tree species (>50% cover)

Plots 0.03 ha
natural regeneration:
stand area (ha) covered by young stems (trees > 20 cm and < 4 m in height)
Inventory data sets

2. Forest Structure Mapping

- protected and unmanaged forests
- 4,298 ha sampled area
- 50 x 50 m grid, circle sampling points 0.1 ha
- Forest stand type for each plot by dominant species or mixtures
- Natural regeneration trees < 7 cm dbh

3. Selective Forest Habitat Mapping

- Rare and protected habitats
- 81,795 ha sampled area
- 26,450 ha rare near natural forest habitats
- Recording of plant associations for each habitat
- Natural regeneration distinguished from artificial regeneration
1. **Proportion of Douglas fir natural regeneration according to the three different inventories**

<table>
<thead>
<tr>
<th></th>
<th>National Forest Inventory</th>
<th>Forest Structure Mapping</th>
<th>Selective Forest Habitat Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area where sampling was carried out (ha)</td>
<td>1 323 119</td>
<td>1 323 958</td>
<td>4 298</td>
</tr>
<tr>
<td>Inventoried area with Douglas fir regeneration (ha)</td>
<td>2 112</td>
<td>4 346</td>
<td>71</td>
</tr>
<tr>
<td>Proportion of forest area with Douglas fir natural regeneration (%)</td>
<td>0.2</td>
<td>0.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*Natural regeneration of Douglas fir occurs only on a very small proportion of the forest area in the State of Baden-Württemberg*
2. **Natural regeneration according to National Forest Inventory**

Largest proportion of natural regeneration found in Douglas fir dominated forest

*Bindewald & Michiels 2016; National Forest Inventory 2012*
3. **Natural regeneration in unmanaged forest areas**

Largest proportion of natural regeneration in Douglas fir dominated forests and Douglas fir-mixes.

The natural regeneration of Douglas fir is negligible in managed as well as in unmanaged forests with the exception of areas where Douglas fir is the dominant tree species in the canopy.

*Binewald & Michiels 2016; Forest Structure Recording 1994-2010*
4. **Natural regeneration in rare protected forest habitats – 2015**

Selective forest Habitat Mapping 2015

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Habitat with Douglas fir (ha)</th>
<th>Entire size habitat (ha)</th>
<th>Portion of habitat with Douglas fir (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural formations</td>
<td>40.6</td>
<td>8,904</td>
<td>0.46</td>
</tr>
<tr>
<td>Rare near-natural forest types</td>
<td>98.8</td>
<td>26,450</td>
<td>0.37</td>
</tr>
<tr>
<td>Forest with animals worthy of protection</td>
<td>6.3</td>
<td>4,356</td>
<td>0.14</td>
</tr>
<tr>
<td>Forest with plants worthy of protection</td>
<td>5.6</td>
<td>4,143</td>
<td>0.14</td>
</tr>
<tr>
<td>Structurally rich forests</td>
<td>11.4</td>
<td>10,500</td>
<td>0.11</td>
</tr>
<tr>
<td>Succession areas</td>
<td>2.5</td>
<td>5,453</td>
<td>0.05</td>
</tr>
<tr>
<td>Dry habitats</td>
<td>0.2</td>
<td>4,585</td>
<td>~0.00</td>
</tr>
<tr>
<td>Running water</td>
<td>0.4</td>
<td>9,234</td>
<td>~0.00</td>
</tr>
<tr>
<td>Marsh and wetland habitats</td>
<td>0.1</td>
<td>4,936</td>
<td>~0.00</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>165.9</strong></td>
<td><strong>81,795</strong></td>
<td><strong>0.20</strong></td>
</tr>
</tbody>
</table>

**Natural formations** covering only small areas, e.g. open rock formations (Photo: Wikipedia; Cliff Scharfenstein, Southwestern Germany.)

Douglas fir regenerating on cliff (photo: A. Reif)
4. Natural regeneration in rare protected forest habitats

Largest proportion of natural regeneration in sessile oak forest communities & mixed broadleaved forest dominated by sycamore.

Very rare habitats in Baden-Württemberg: forests with sparse tree cover on acidic nutrient poor sites.

The natural regeneration of Douglas fir can be found only in several protected forest habitats such as natural formations and rare near-natural forest types.

Bindewald & Michiels 2016; Selective Forest Habitat Mapping 2015
Discussion case study – managed and unmanaged forests

*Natural regeneration currently occurs at a rather low level*

- Natural regeneration primarily in forest areas where Douglas fir forms a dominant species in the canopy
- In Douglas fir stand types natural regeneration typically desired
- Potential to spread associated with forest management practices, no overwhelming evidence of its wider spread detected
- Number of seed producing trees may increase in future
  - currently 45 % of Dgl stand types less than 40 years old (NFI 2012)
Discussion case study – protected forest habitats

*Douglas fir may be considered as invasive tree species in special protected rare habitats*

- Tree species may have negative influence on native biodiversity

- control of natural regeneration still possible
  - natural regeneration found in 98 ha protected forest habitats

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**Set up appropriate buffer zones around valuable habitats**

*(what is appropriate?)*
Discussion case study – assessment of invasiveness

- **Case study** highlighted the need to differentiate invasiveness between different forest ecosystems

- **Data on natural regeneration** as valuable factor when assessing invasiveness
  - Can indicate establishment success in specific forest ecosystems
  - Improve management of protected habitats

- But of course…
  - …data covers only one aspect of the invasiveness of an introduced tree species

Research efforts are necessary in order to collect/analyse additional data and further develop solid standardised risk assessment tools
Questions?

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