Deutsche Forschungsgemeinschaft DFG

*Tackling climate change: the contribution of forest scientific knowledge , Tours (France), 21/05/2012*

Johann Heinrich von Thünen-Institut

# Disturbance-driven northwards spread of European beech in Southern Sweden


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# Outline



- Climate change – implications for southern Sweden
- Site and methods
- Disturbance effects on European beech and competing Norway spruce
- Effects on spruce-beech competition dynamics
- Theory of (future) beech superiority

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# Climate change – implications for southern Sweden

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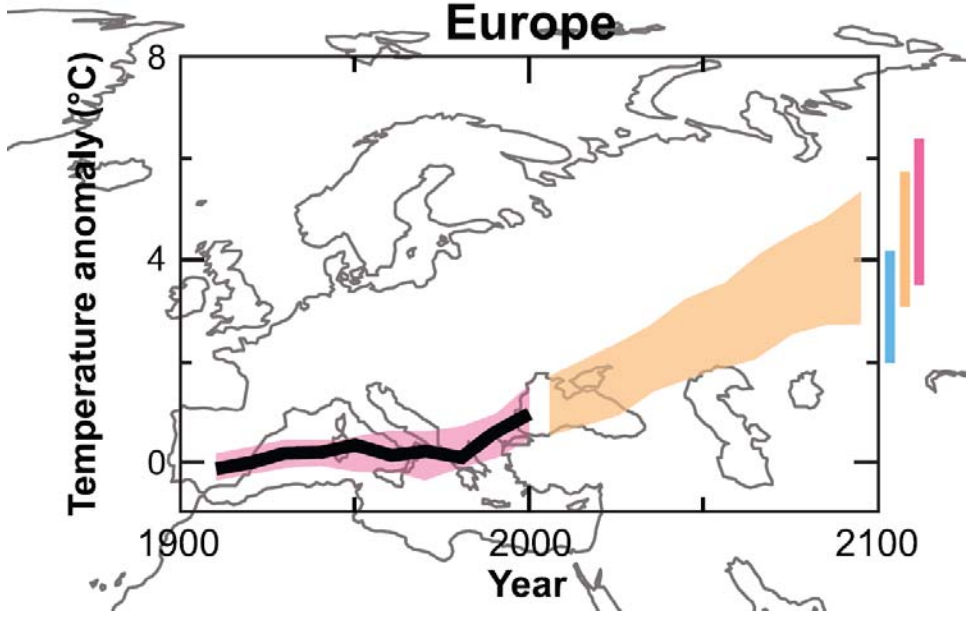
# Climate change



**Change of T and P in Scandinavia (1991-2000 to 1961-1990): T +0.8°C, P +6%, mostly in winter (*Räisänen & Alexandersson 2003*), Projection 2100: T +4°C, P +11% *(Lind & Kjellström 2008)***

**Projections Europe 2100 (*IPCC, 2007)*:**

- **Temperature: +2.0°C to +6.2°C (min. SRES B2 to max. A2 scenario)**
- **More extremes: more frequent and intensive heat waves and droughts, increase of storm events (northern Europe)**




**Source:**
IPCC., *2007*
*(4tf Assessment IPCC report)*

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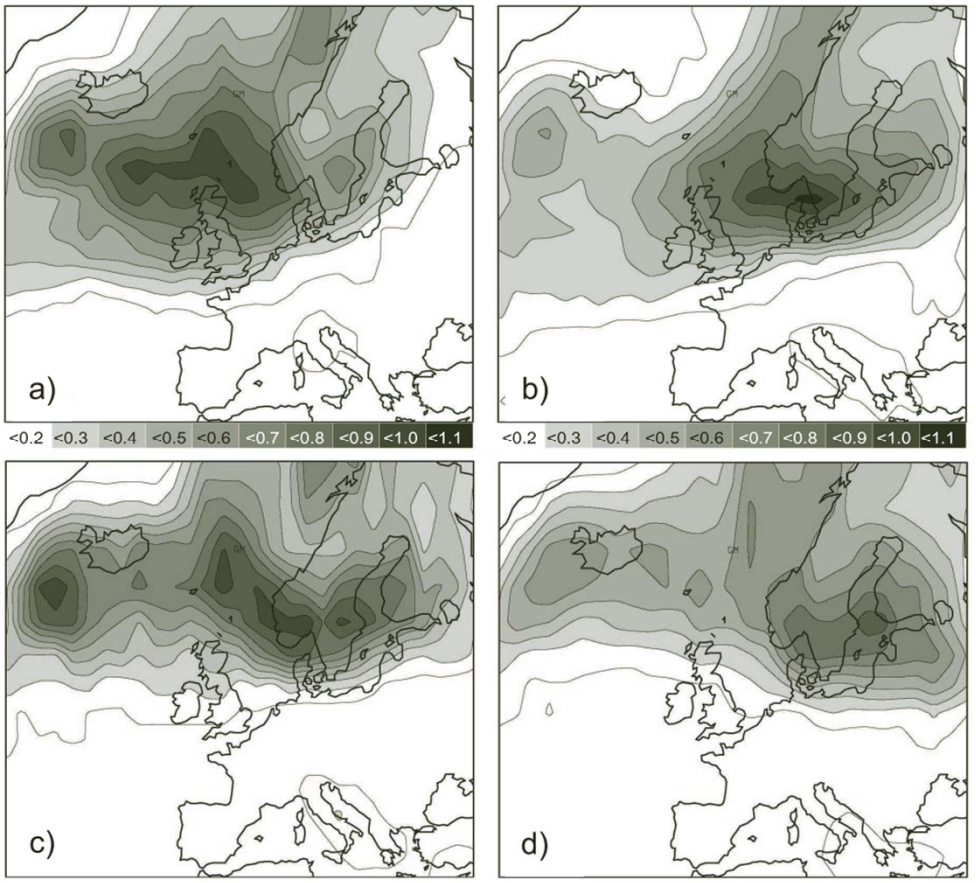
# Storm risk




**Standardized cyclone track density**

**Northern central Europe (incl. southern Sweden) are often affected by storm.**

**An increase of extreme wind intensity for this region is projected (*Leckebusch et al., 2006*).**

**Source:** *Leckebusch et al., 2006*

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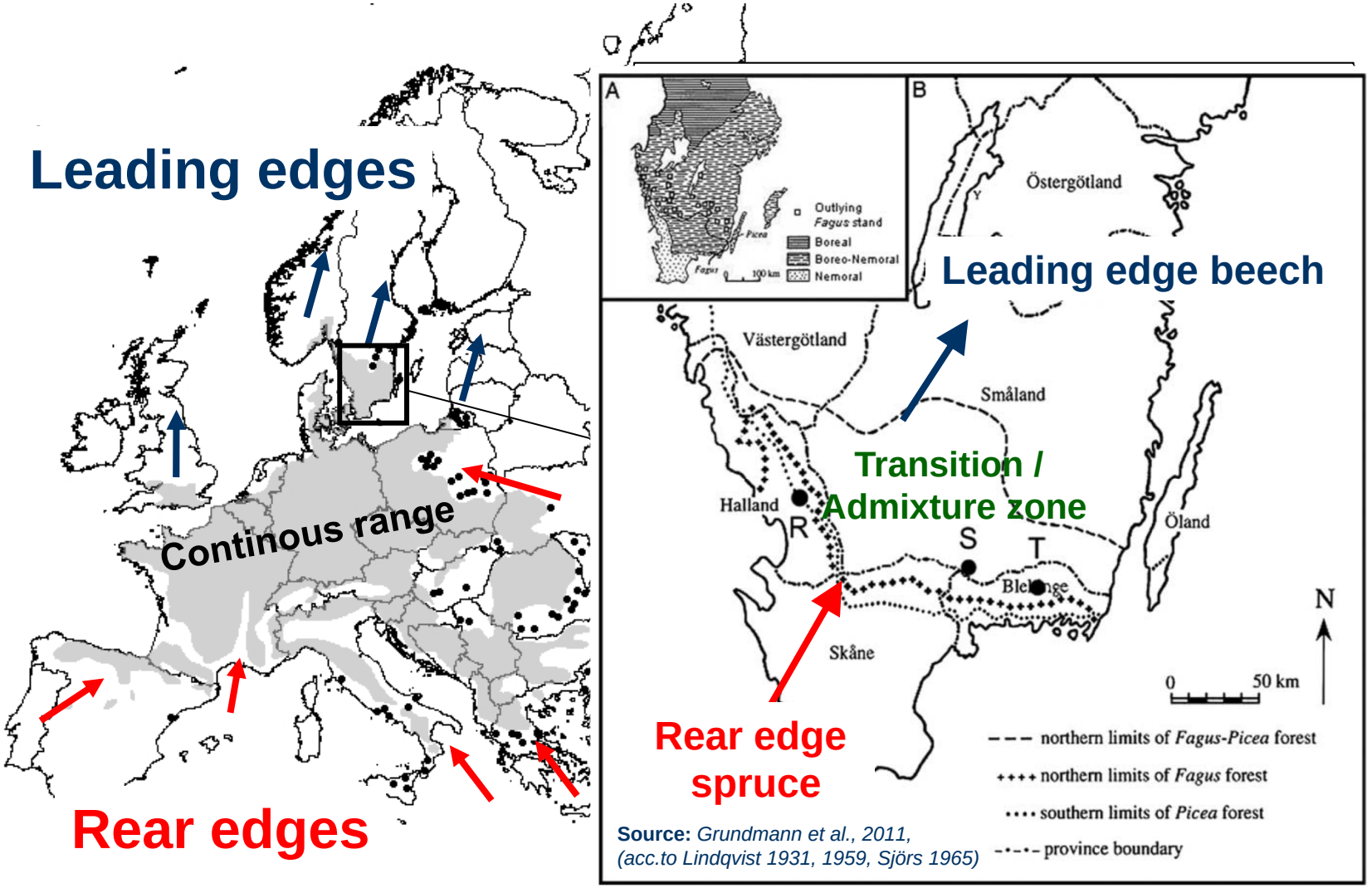
# European beech range




**Source:** *Bolte et al., 2007, modified*

**Source:** *Grundmann et al., 2011, (acc.to Lindqvist 1931, 1959, Sjörs 1965)*

# Research hypotheses



- **The projected northward extension of the beech is the result of:**
  - **Higher tolerance to and/or resilience after (CC driven) disturbances compared to spruce.**
  - **increased competitive vigour and higher growth performance relative to spruce**
- **What could be the main causes for beech range shift in future?**
- **What driving processes are responsible?**

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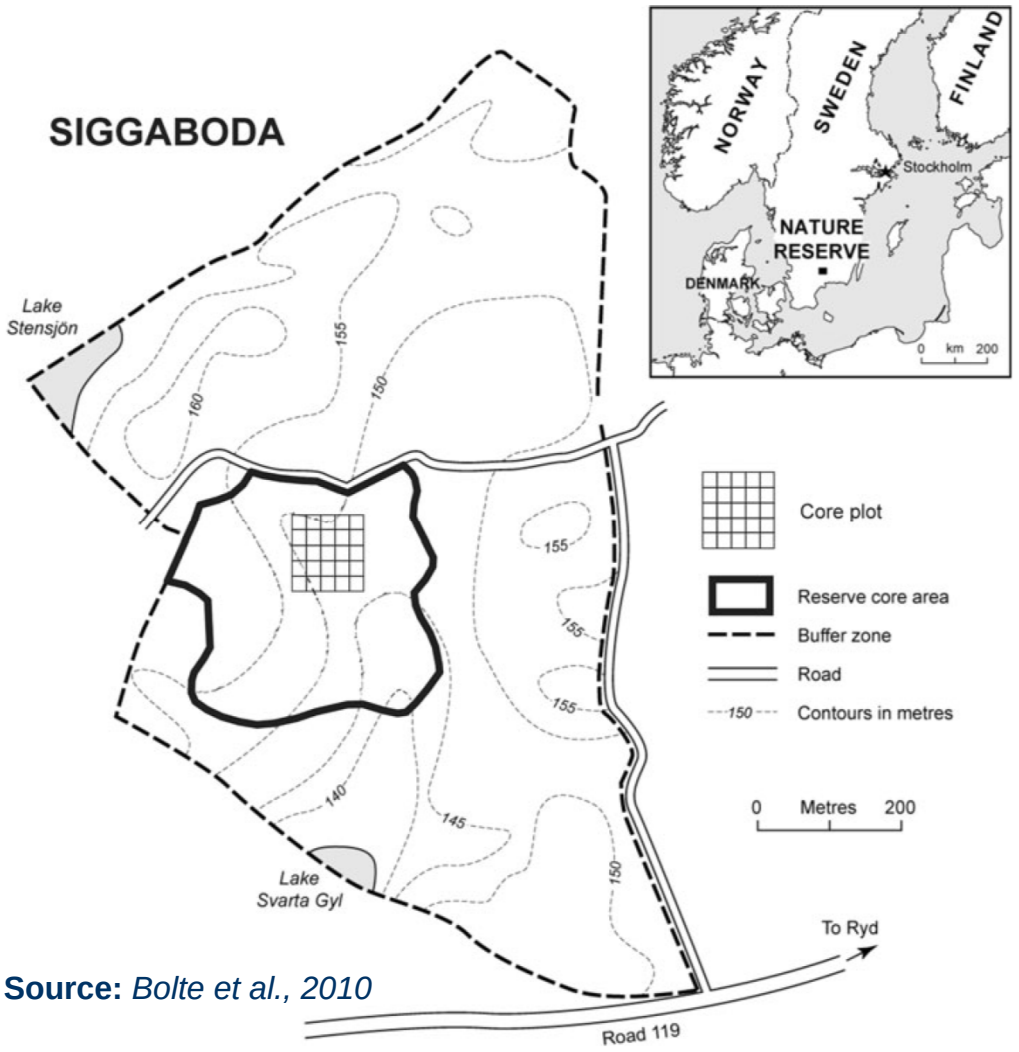
# Site and methods

# Site Siggaboda, about 100 years untouched




**Source:** *Bolte et al., 2010*

| | Siggaboda |
|---|---|
| **Location** | Kronobergs län, 10 km SE Härlunda |
| **Altitude (m a. s. l.)** | 140-150 |
| **Slope orientation** | variable |
| **Mean annual T (C)** | 6 |
| **Mean T. May-Sep (C)** | 12 |
| **T. range year (C)** | 17 |
| **Prec. (mm/yr)** | 700 |
| **Bedrock** | Gneissic granite |
| **Substrate** | Silty sand |
| **Soil type** | Dystric Cambisol |
| **Moisture status** | High (partly boggy) |
| **Nutrition status** | Low to moderate |
| **Stand** | Beech up to 230 yrs., Spruce up to 210 yrs. (+nat. regeneration) |
| **Proportion spruce and beech (%)** | 60/40 |

# 1000 years of forest history at Siggaboda

## Charcoal fragments, Pollen percentage and tree-ring analysed trees

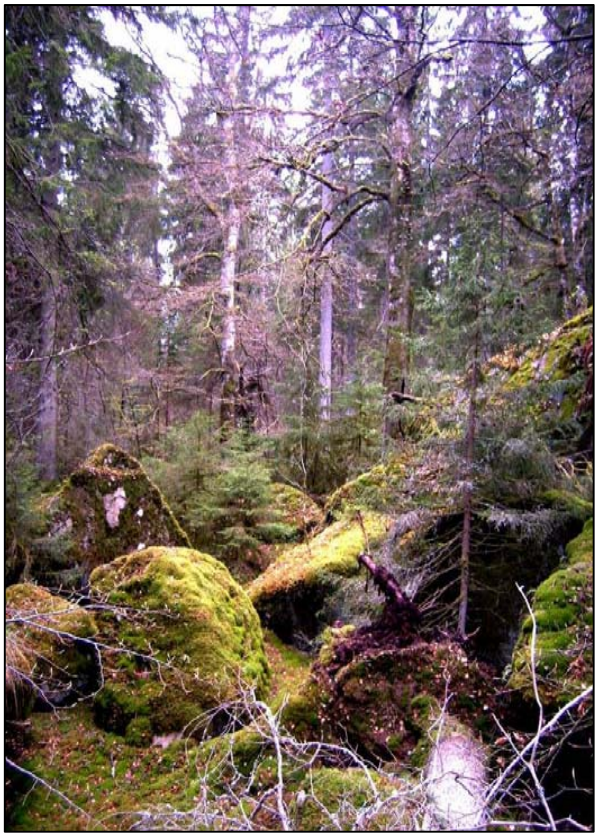
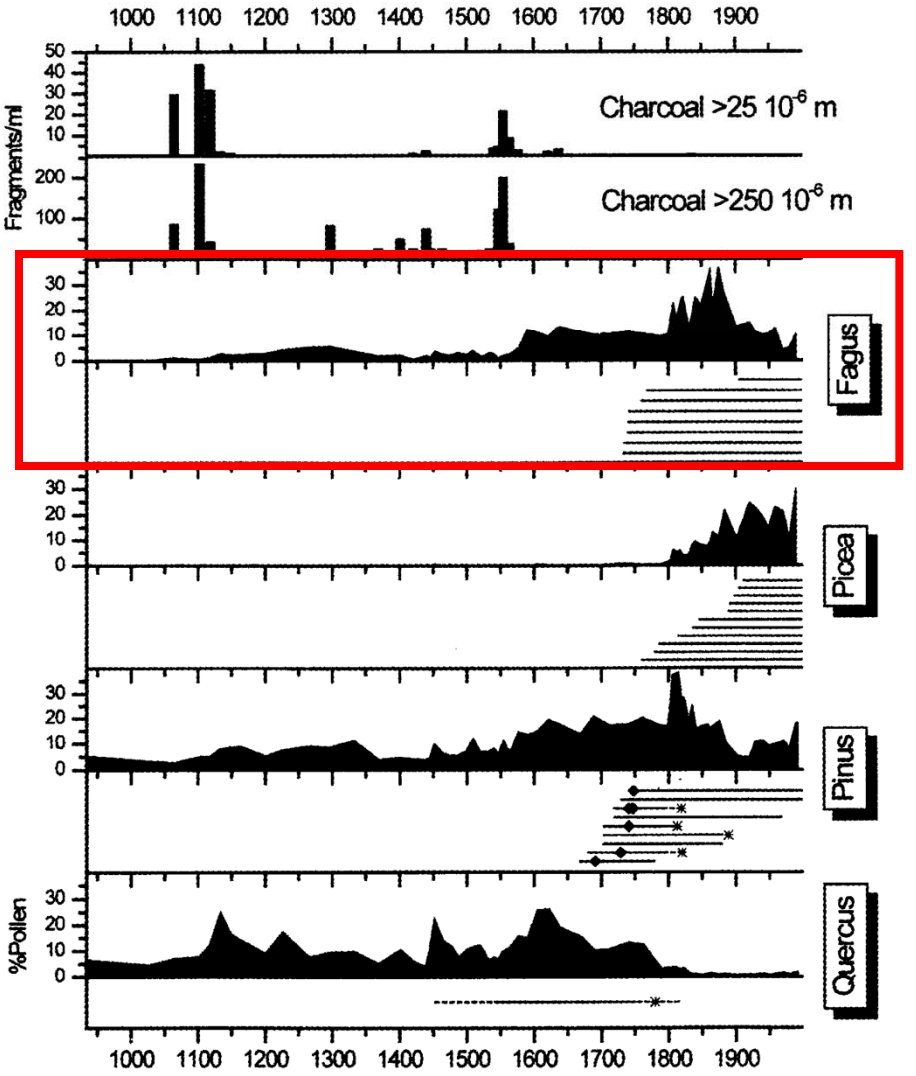


Photo: Andreas Bolte




Source: *Niklasson et al., 2002*

# Stand structure recordings (2004 – 2011)

**In 2004:**

- **Permanent marking of a grid**
- **Stem position recording and dbh measurements of each tree (dbh >7cm)**
- **Height recordings (crown base, height of max. crown width and tree height)**

**In 2005:**

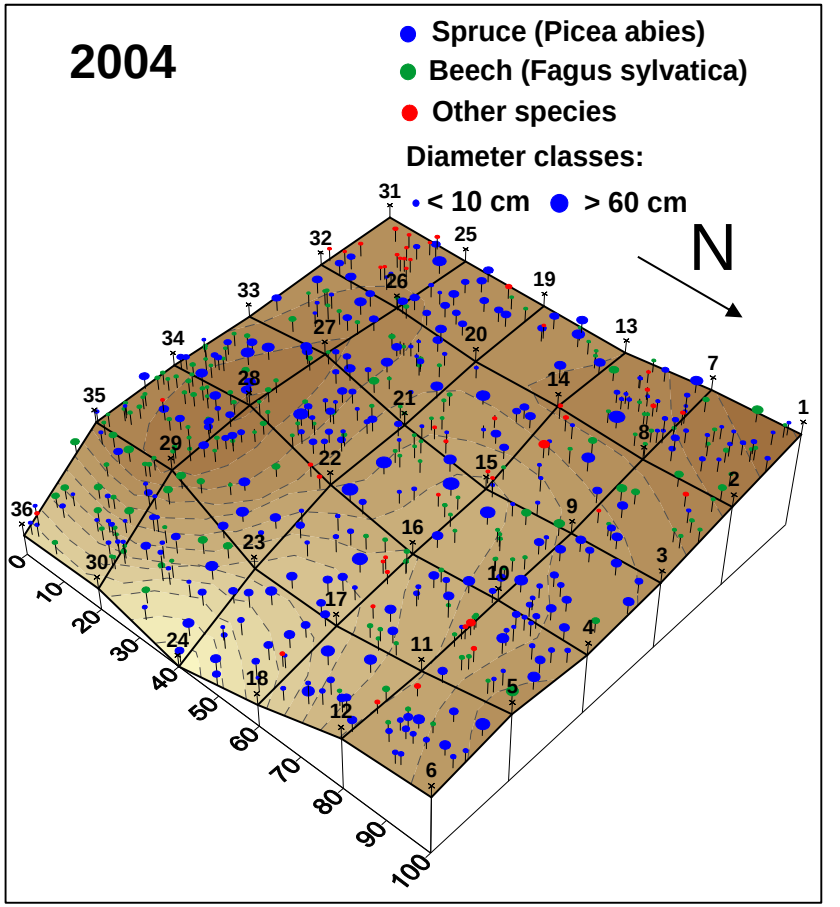
- **Crown mapping (8 lateral points)**
- **Storm damage recordings**
- **Tree coring and dendroecological analyses**

**In 2007 and 2009:**

- **Recording of biotic damages (bark beetle impact)**

**In 2011:**

- **Second stand recording with stem position, dbh and heights (dbh >7cm)**




**Source:** *Bolte et al., non published*

# Disturbance effects on European beech and competing Norway spruce

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# Siggaboda 2004 (Study start)

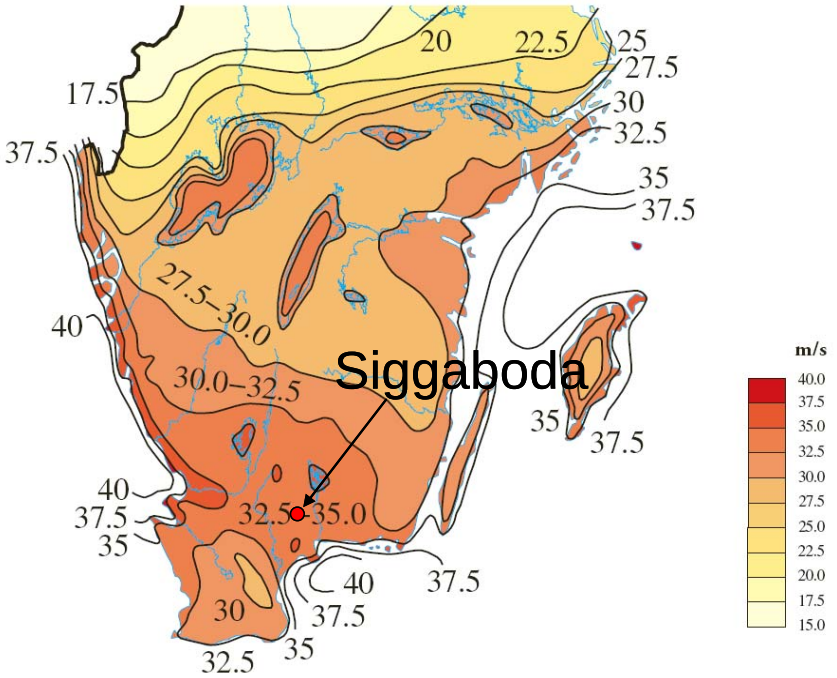
Photo: Andreas Bolte

Photo: Andreas Bolte

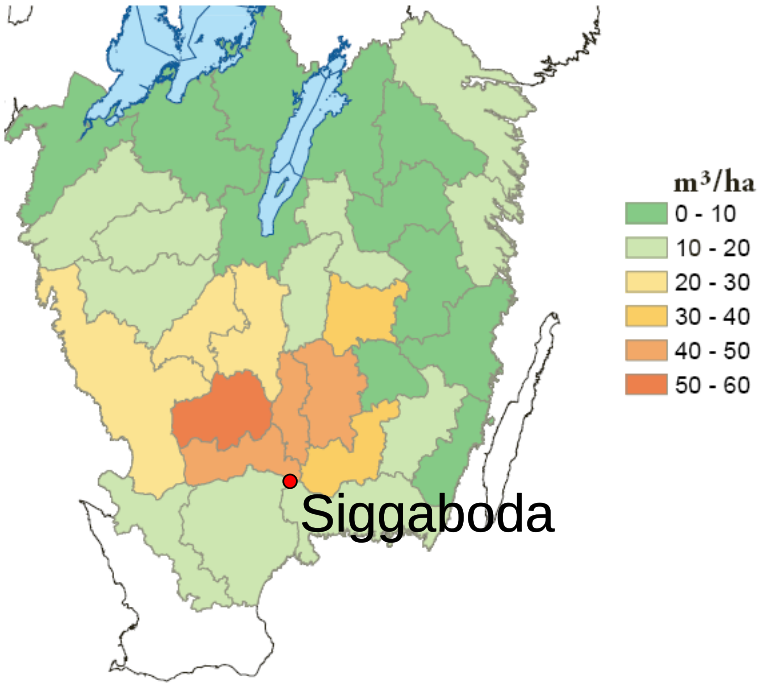
# The 'Gudrun' storm (8-9/01/2005)

- **Maximum wind velocity: up to 42 m/s (Blekinge/S),**
- **341,000 households without electricity**
- **160,000 ha damaged forests, 75 mill. m³ wood volume**
- **Damage: 2,25 billion €**

## Mean wind velocity




## Mean wind-thrown wood volume




**Source:** *SMHI, 2005*

# Siggaboda 2005, storm damages



Photo: Marcus Kühling

**Thrown spruce group**

Photo: Andreas Bolte

**Secondarily damaged beech (by thrown spruce)**

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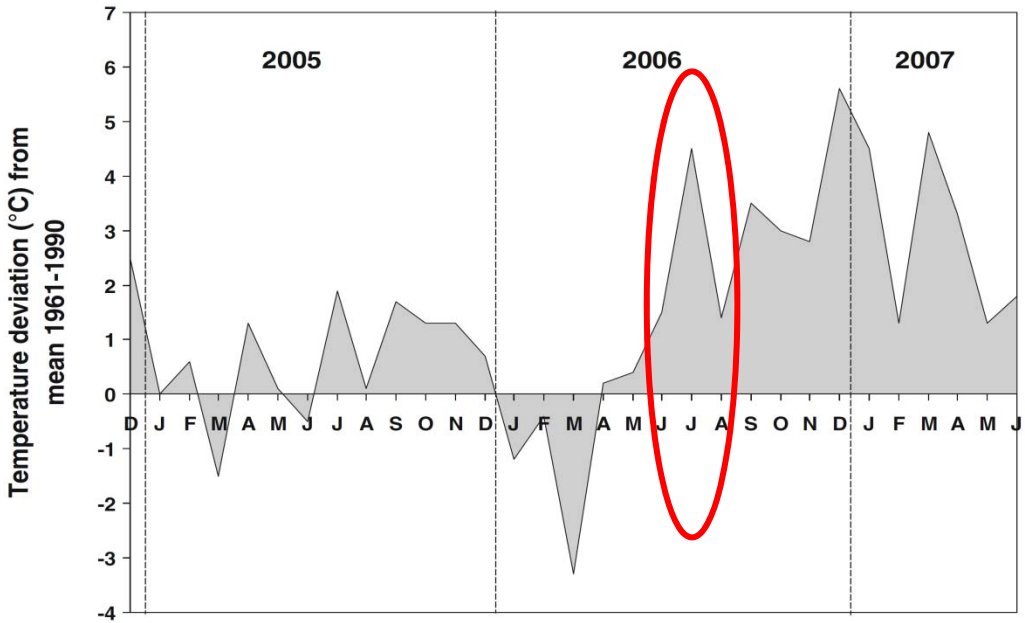
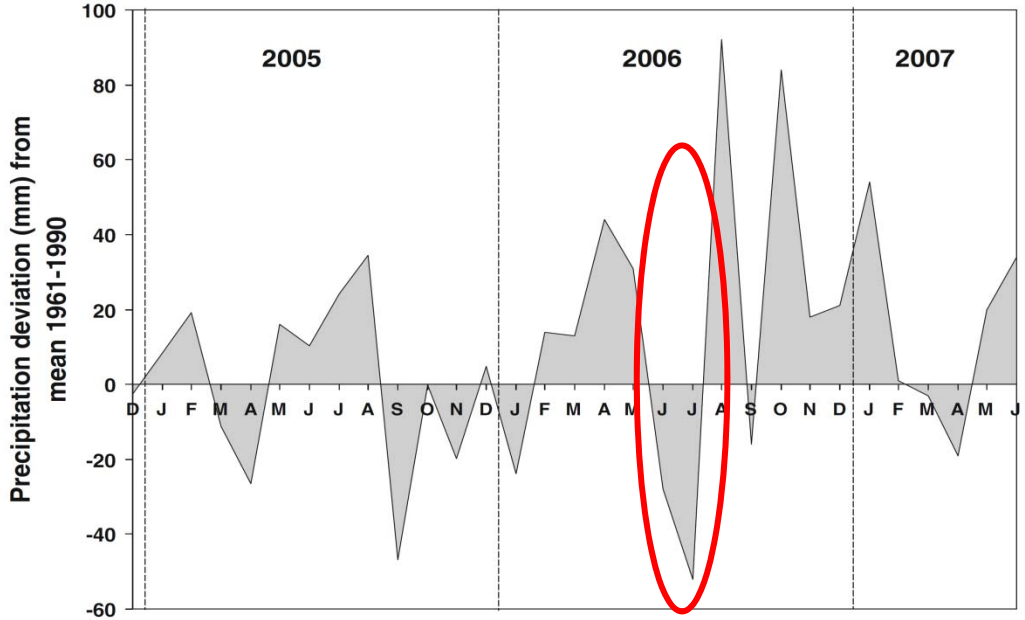
# Summer drought 2006

- **Exceptional heat wave June/July 2006 (also warm autumn)**
- **Water deficit in June/July 2006**
- **+ remaining breeding material for bark beetles**




**Source:** *Bolte et al., 2010*

# Siggaboda 2007 – after bark beetle attacks



Photo: Andreas Bolte

**Standing dead spruce (height ca. 40 m)**

Photo: Andreas Bolte

**Dead spruce overstorey, living beech understorey**

# Siggaboda 2009/2011 – after bark beetle attacks



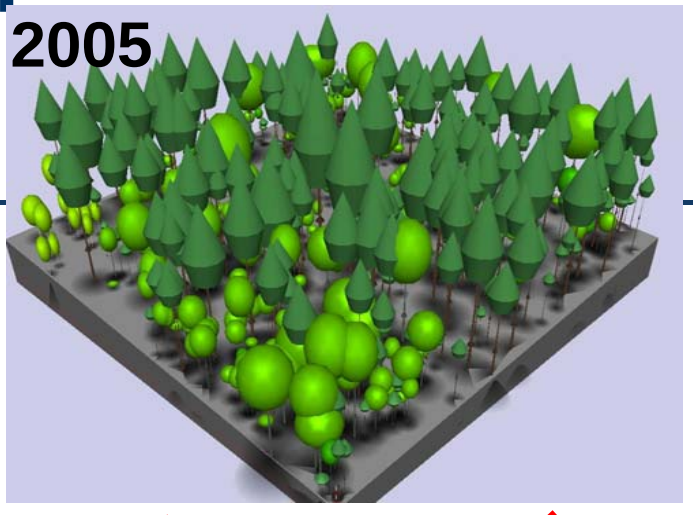
Photo: Andreas Bolte

**Spruce overstorey nearly completely dead**

Photo: Andreas Bolte

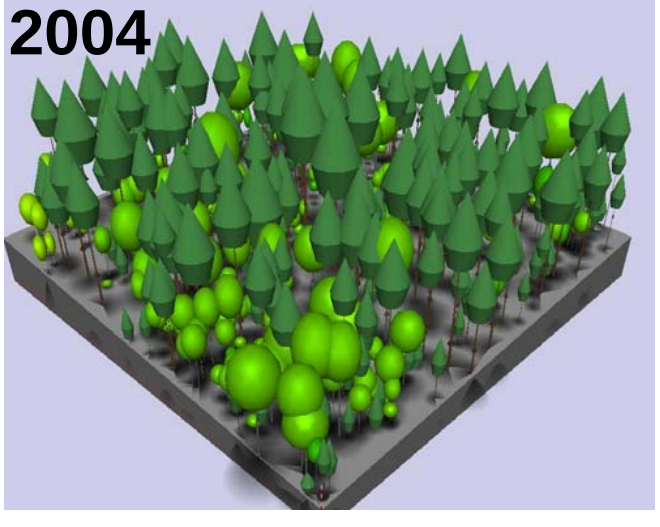
**Light-demanding herbs on the forest floor (*Epilobium angustifolium*)**

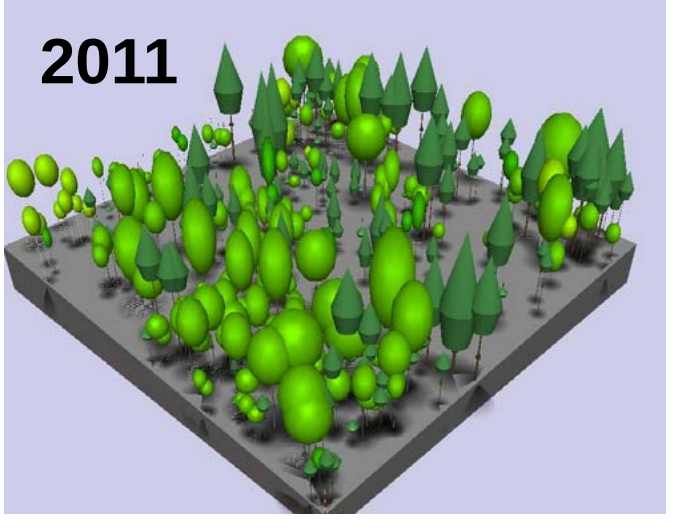
# Comparison 2004 to 2011




High resistance to storm (Storm damage, Spruce: only 11% BA loss)

Low resistance of spruce towards bark beetle attacks (75% BA loss)

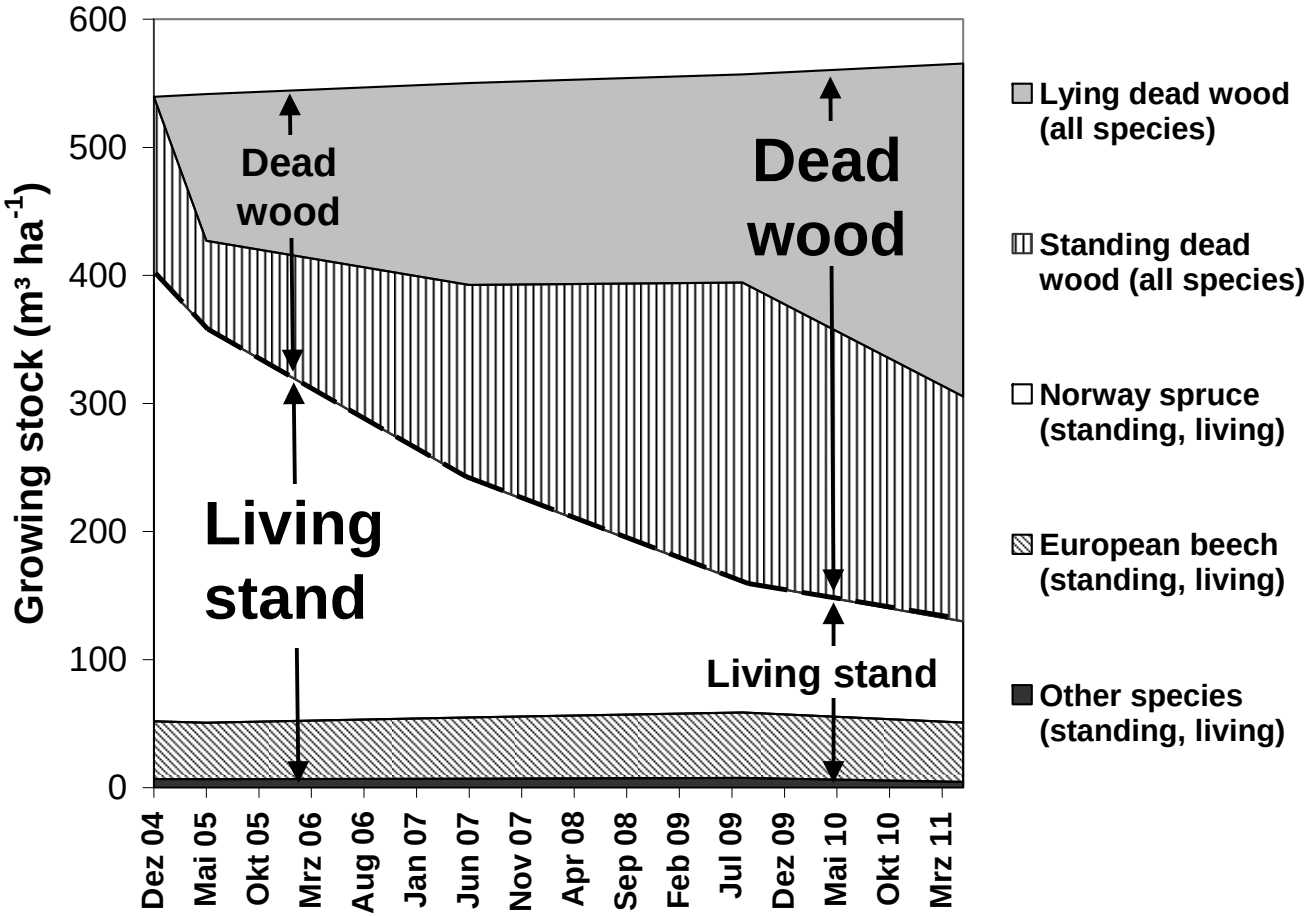



**Source:** *Bolte et al., in prep.*

# Growing stock dynamics

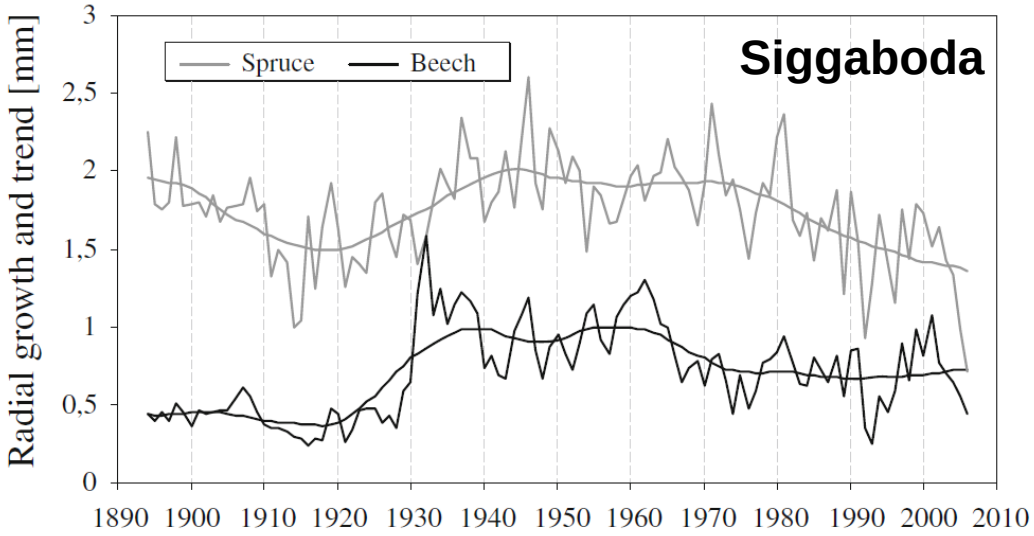





**Source:** *Bolte et al., 2010 (modified)*

# Effects on the spruce-beech competition dynamics

# Diameter increment (tree cores)



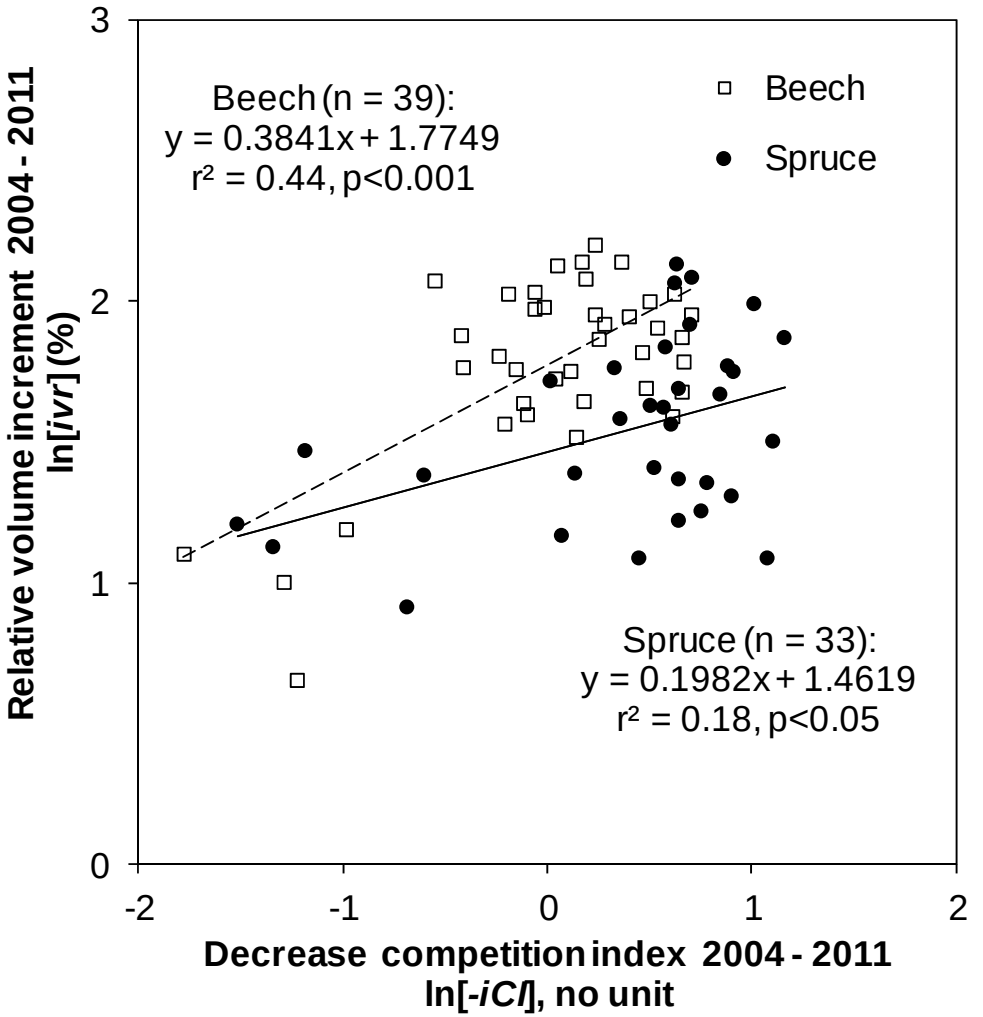

**Source:** *Bolte et al., 2010*

| Site | Species | Diameter increment % of long-term mean | | Increment ratio spruce/beech (%) | |
|---|---|---|---|---|---|
| | | 1894–1949 | 1950–2005 | 1894–1949 | 1950–2005 |
| Siggaboda | Beech | 88.1 | 111.7 | | |
| | Spruce | 100.7 | 99.3 | 282.4 | 219.6 |
| Tolseboda | Beech | 106.2 | 93.9 | | |
| | Spruce | 109.0 | 91.1 | 206.4 | 195.1 |

**Source:** *Grundmann et al., 2011*

# Higher resilience ability of beech

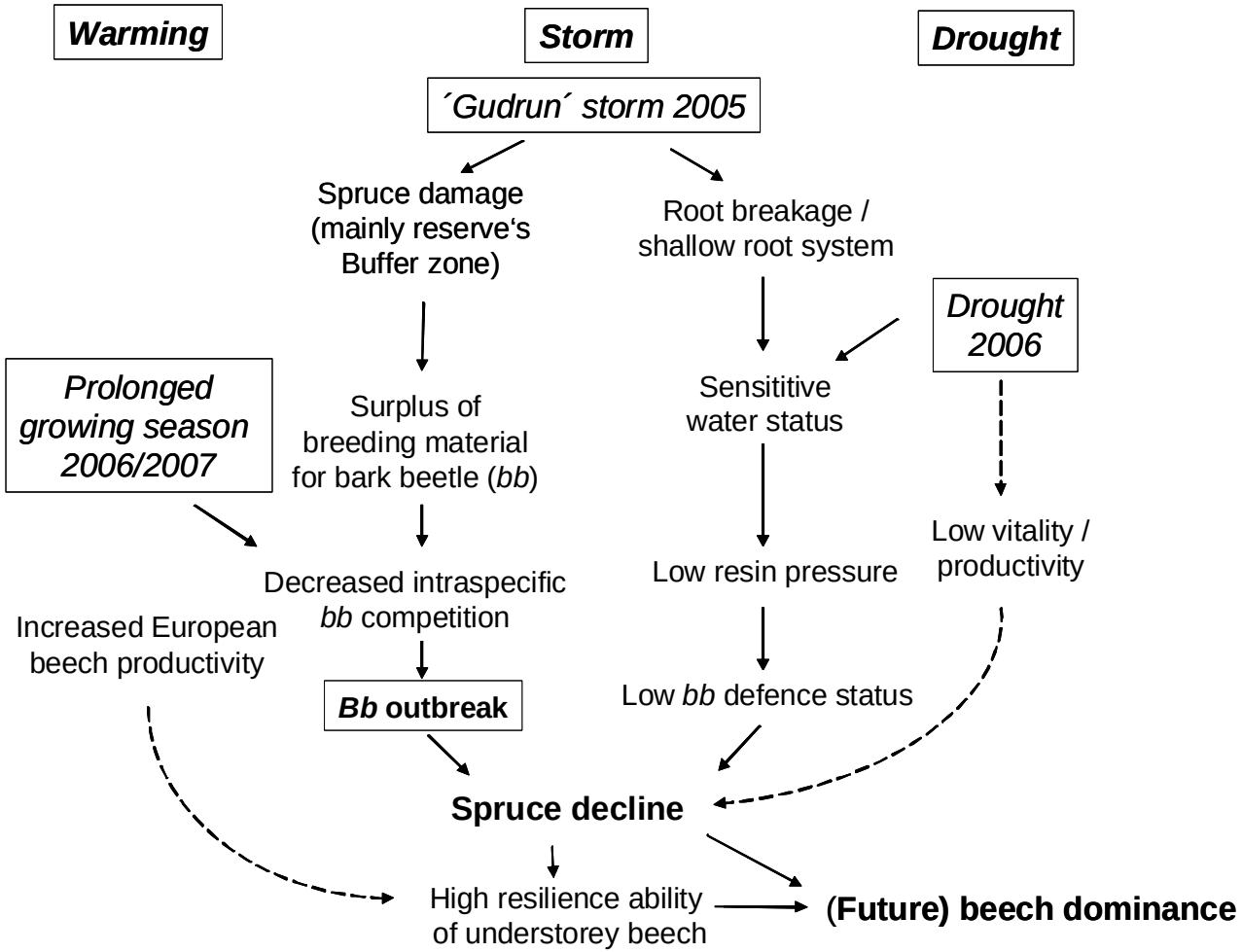





**Source:** *Bolte et al., in prep.*

# Theory of spruce decline and (future) beech superiority






**Source:** *Bolte et al., in prep.*

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# Literature


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