# Disturbance v lesních ekosystémech

Ing. Pavel Šamonil, Ph.D.


Tento projekt je spolufinancován Evropským sociálním fondem a Státním rozpočtem ČR InoBio – CZ.1.07/2.2.00/28.0018

# Disturbance stromového patra I

temperátní lesy

Foto: Igor Míchal

# Check-list of research plots in the Czech Republic

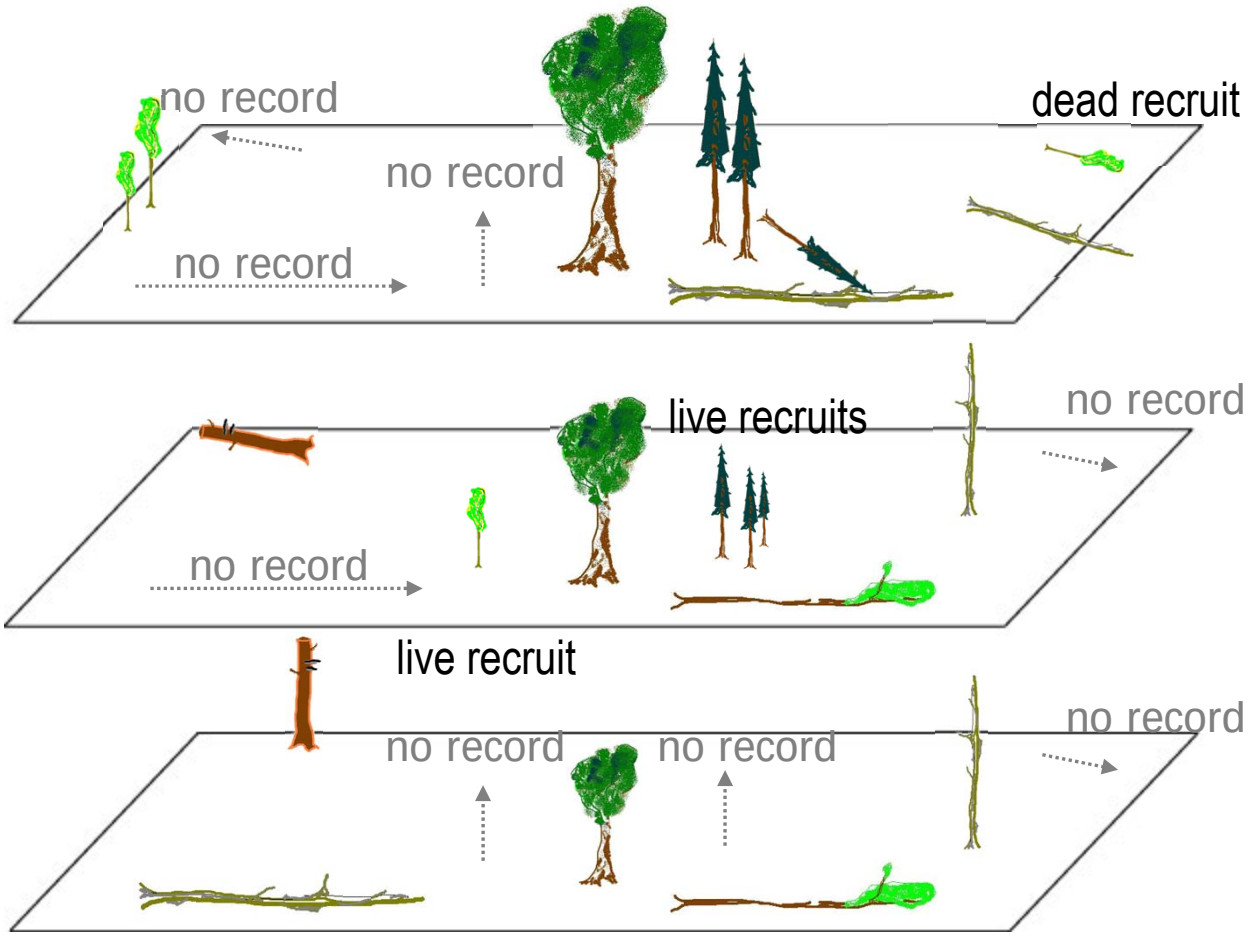
| Locality | Altitude m a.s.l. max. | Area [ha] | Data collection 50s. | 70s. | 90s. | 00s. | Living trees no. | Dead trees no. | Relevés no. | Soil profiles no. |
|---|---|---|---|---|---|---|---|---|---|---|
| Cahnov-Soutok | 152 | 17.32 | | x | x | x | 4091 | 505 | 9 | 5 |
| Ranšpurk | 155 | 22.25 | | x | x | x | 6001 | 767 | 15 | 5 |
| Jiřina | 163 | 1.82 | | x | x | | 1164 | 77 | 2 | 1 |
| NP Podyjí - Lipina | 365 | 4.59 | | | | x | 3495 | 1795 | 8 | 3 |
| NP Podyjí - Šobes | 392 | 2.37 | | | | x | 1636 | 126 | 0 | 0 |
| Velká Pleš | 500 | 10.45 | | x | x | | 4543 | 974 | 2 | 2 |
| Diana | 532 | 19.78 | | | x | | 2177 | 201 | 5 | 5 |
| Kohoutov | 568 | 25.29 | | x | x | | 2017 | 427 | 16 | 3 |
| Sidonie | 571 | 13.50 | | | | x | 3555 | 220 | 9 | 2 |
| Polom | 625 | 19.34 | | x | x | | 7650 | 602 | 19 | 4 |
| V Klučí | 683 | 1.50 | | x | | x | 190 | 97 | 4 | 2 |
| Žákova hora | 800 | 17.46 | | x | x | x | 5962 | 679 | 22 | 6 |
| Razula | 812 | 22.84 | | x | x | x | 4073 | 761 | 15 | 5 |
| Salajka | 820 | 19.03 | | x | x | x | 7834 | 741 | 21 | 5 |
| Žofín | 837 | 74.20 | | x | x | x | 18899 | 2862 | 48 | 10 |
| Mionší - Řehák I. | 850 | 1.00 | x | | x | x | 433 | 81 | 0 | 0 |
| Mionší - Chmelař A | 884 | 2.54 | x | | | x | 1325 | 370 | 0 | 0 |
| Hojná voda | 885 | 8.94 | | | x | | 3720 | 173 | 3 | 1 |
| Mionší - VÚKOZ | 890 | 5.92 | | | x | x | 2368 | 233 | 5 | 2 |
| Stožec | 900 | 16.21 | | x | x | | 2884 | 566 | 17 | 2 |
| Boubín | 1105 | 46.62 | | x | x | x | 13123 | 3357 | 23 | 5 |
| Milešice | 1125 | 8.86 | | x | x | x | 2790 | 393 | 3 | 3 |
| Bílá Opava | 1352 | 1.23 | | x | x | | 222 | 28 | 8 | 2 |
| **Celkem** | | 363.06 | | | | | 100152 | 16035 | 254 | 73 |

# Dendrometrical data

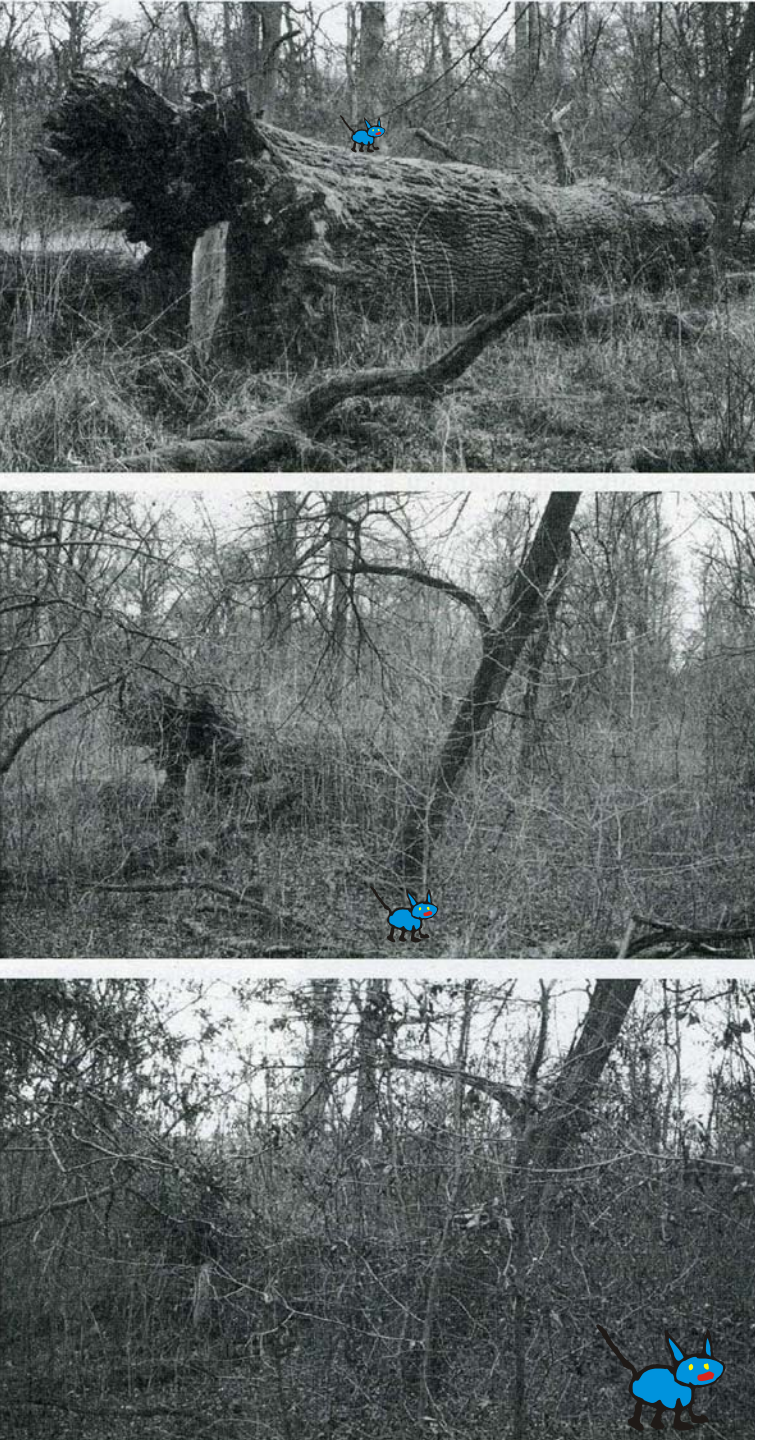
2000s
Žofín: 2008

1990s
Žofín: 1997

1970s
Žofín: 1975




no record – stem (still/already) doesn´t exist or doesn´t reach threshold d.b.h.



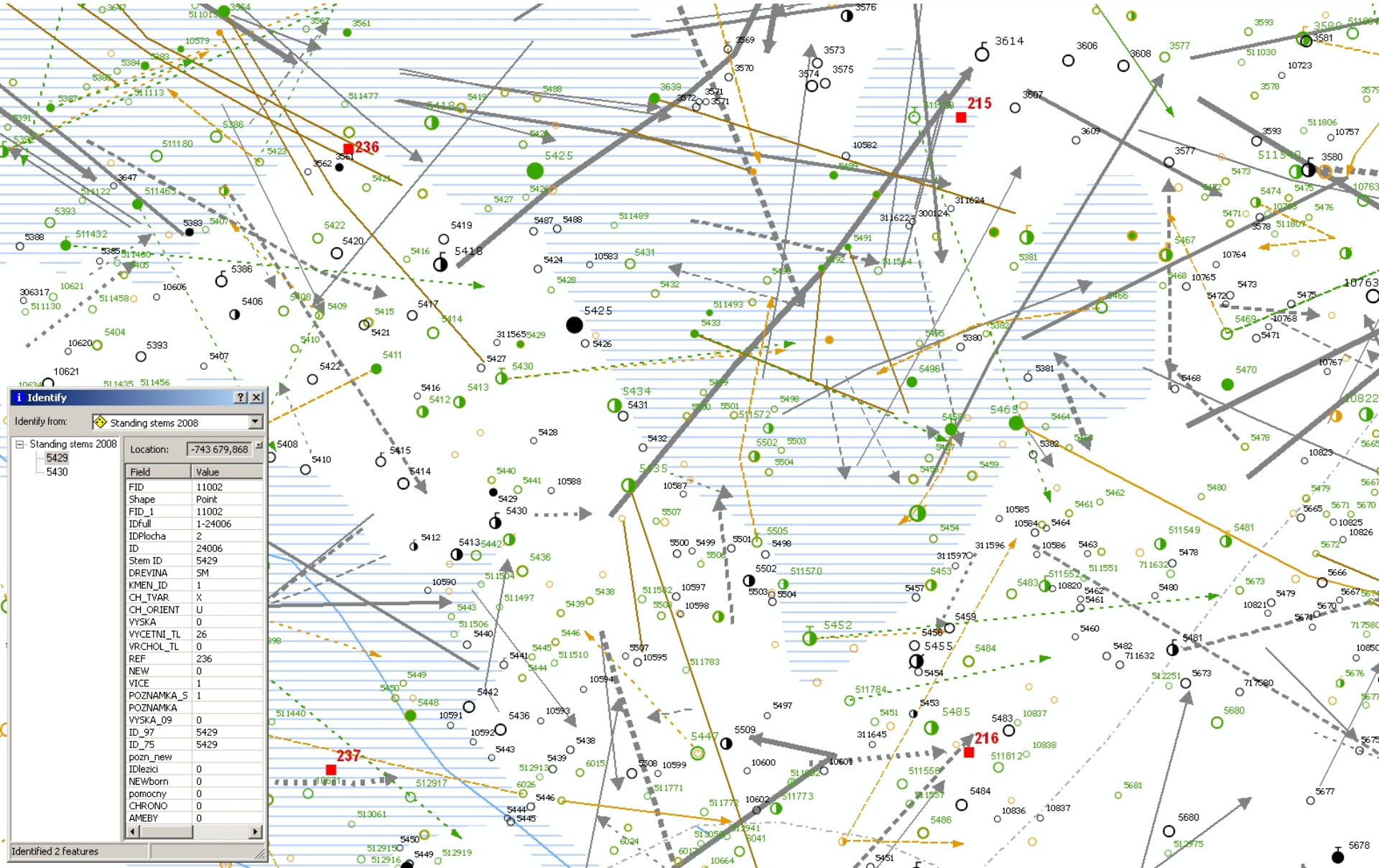
# Limits of dendrometrical data

- Lower limit of tree diameter is DBH ≥ 10 cm

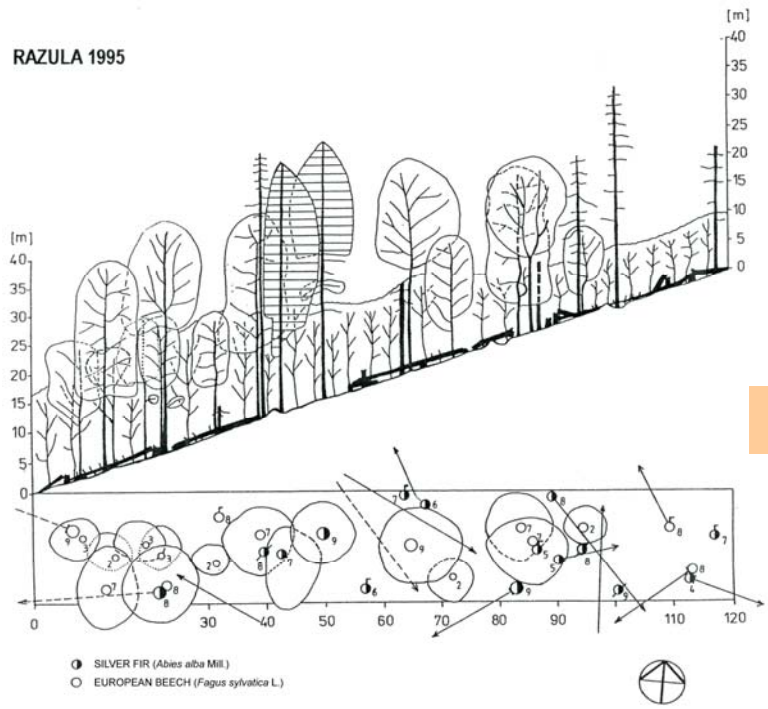
(+ natural regeneration mapping)

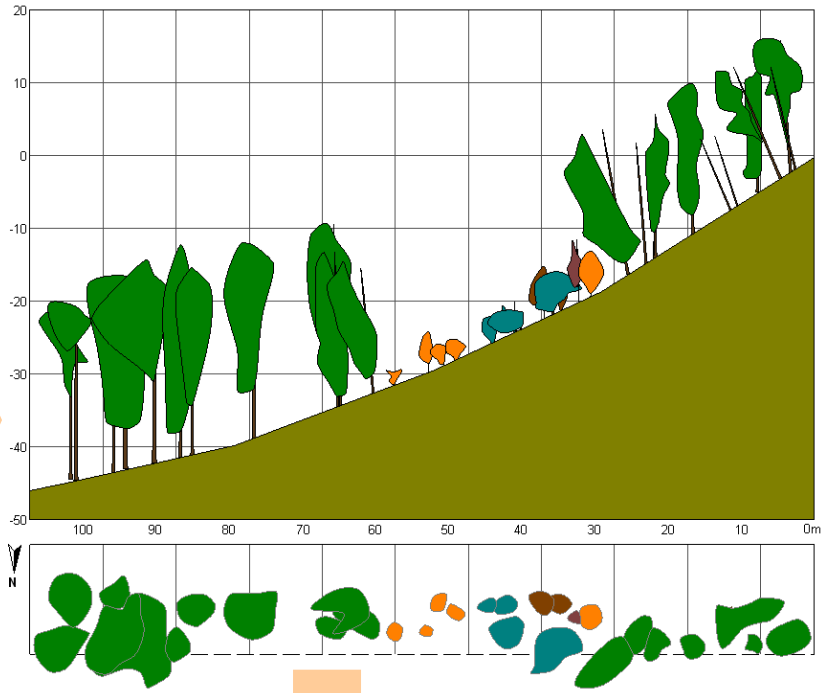
- Deadwood measurement - 3 decay stages only
- Determining year of death becomes less accurate for older logs (1 year → 10 years → >20 years)
- Stem volumes, not tree volumes

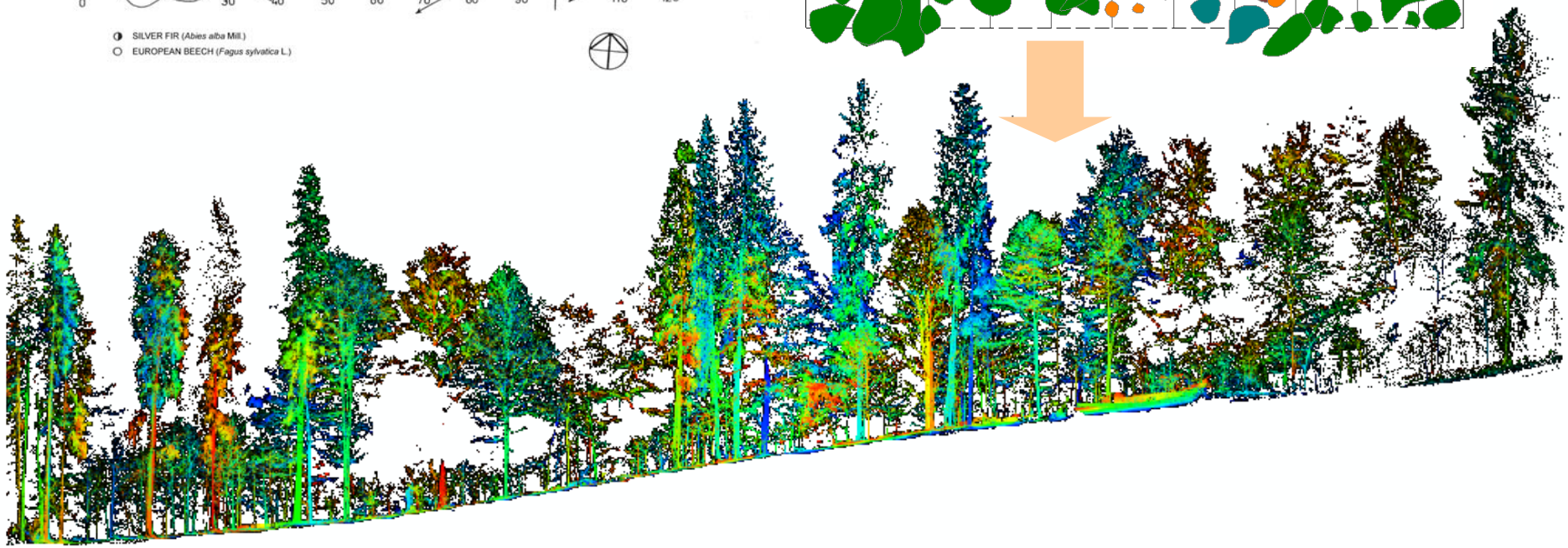
# Žofín – stem position map (1975-1997-2008)



# Technological development of data collecting



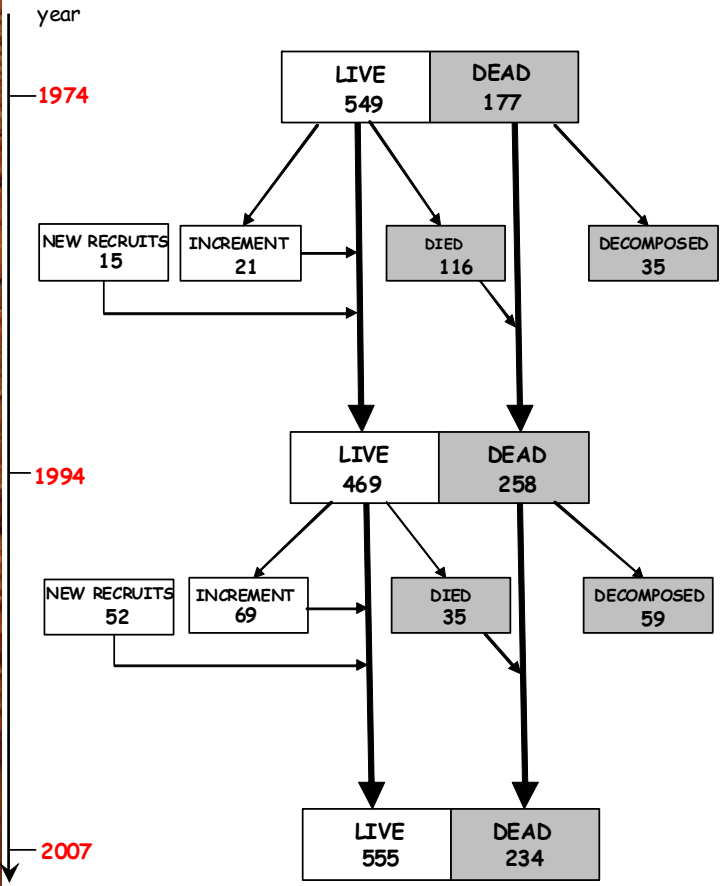



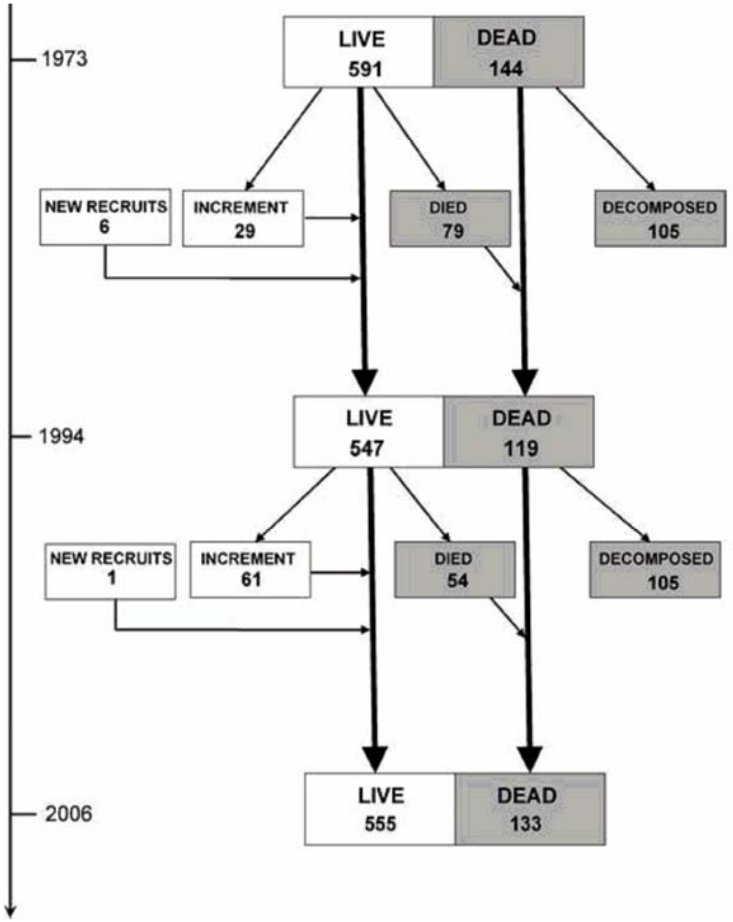
# Tree layer dynamics

- How does volume of stem biomass change over a cycle of growth and decay

Mountain fir-beech forest ($m^3$/ha)

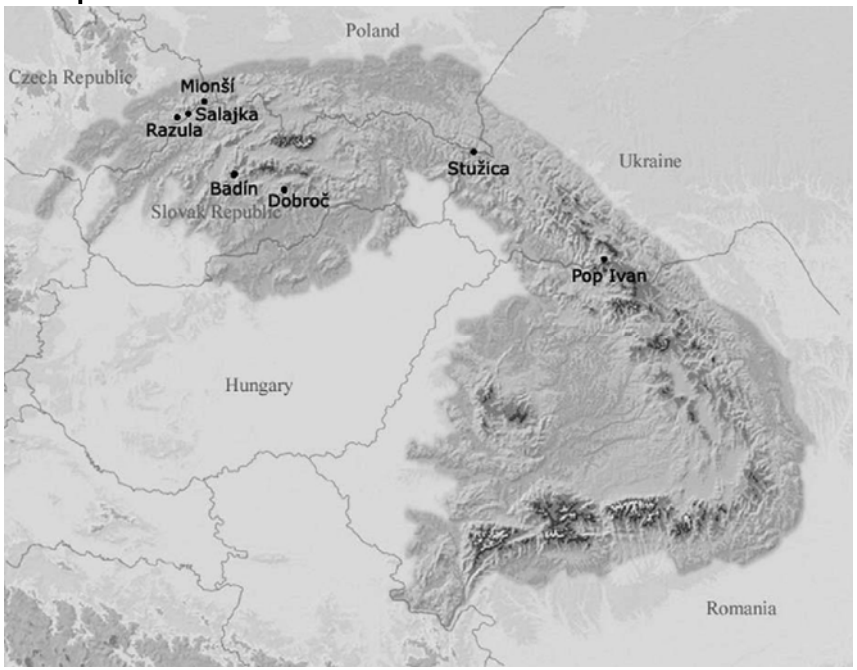


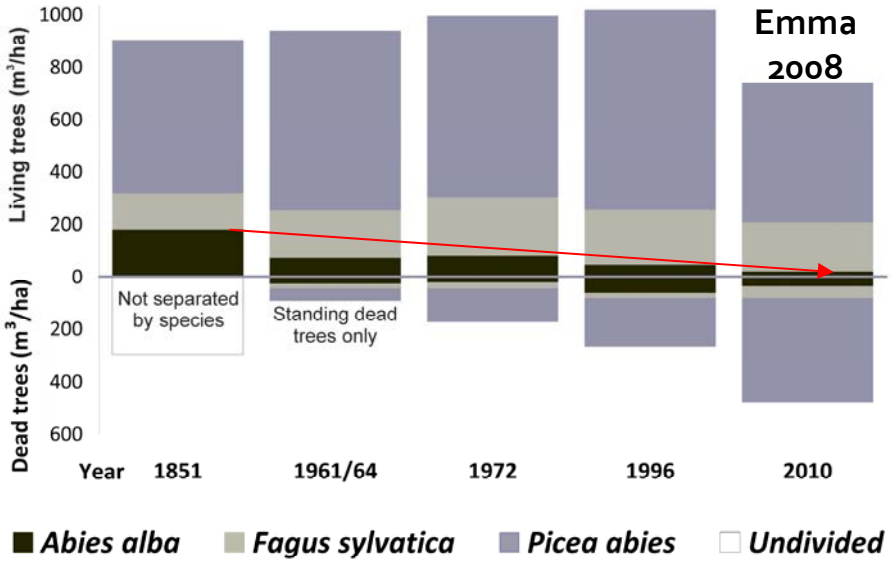

Floodplain oak forest ($m^3$/ha)




Janik D., Adam D., Vrska T., Hort L., Unar P., Kral K., Šamonil P., et Horal D., 2008. Tree layer dynamics of the Cahnov–Soutok near-natural floodplain forest after 33 years (1973–2006). Eur. J. For. Res. 127: 337-345

# Carpathian Arch

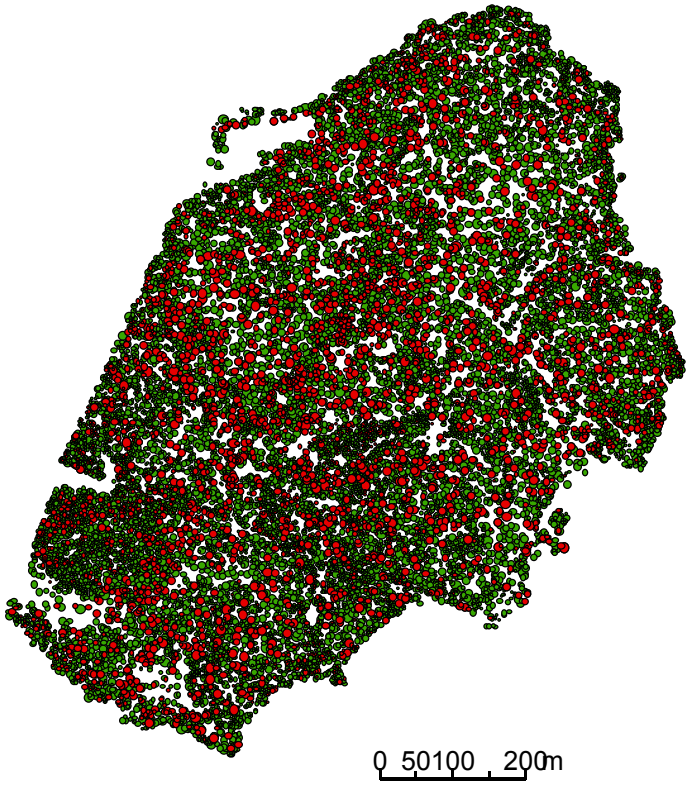


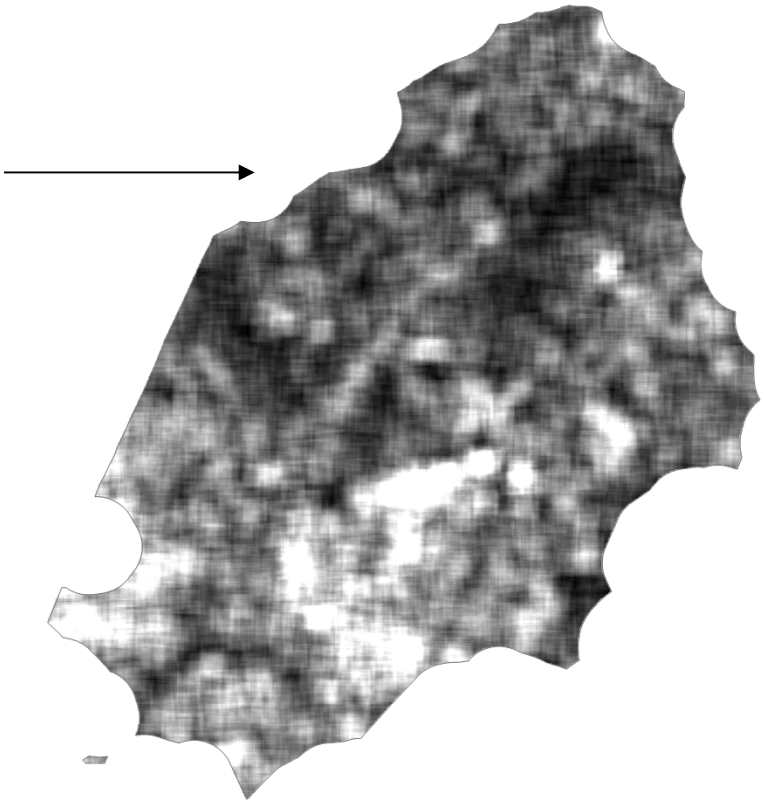




- The sum of dead and living wood volume is stable in the long-term (during the 159 year period with deviations of only up to 5%).
- However, inner structure of wood volume is variable
- The proportion of *Abies alba* continually decreases (from 20% in 1851 to 2–3% in 2010)
- The proportion of *Fagus sylvatica* slightly increases
- Increase of mesophyllous taxa in lowlands

Tomáš Vrška, Dušan Adam, Libor Hort, Tomáš Kolář, David Janík. 2009. European beech (Fagus sylvatica L.) and silver fir (Abies alba Mill.) rotation in the Carpathians—A developmental cycle or a linear trend induced by man? For. Ecol. Manag. 258: 347–356

# Spatial variability of stem biomass



74 ha, 20.000 trees

Live trees (DBH)

- 10 – 25 cm
- 26 – 50 cm
- 51 – 75 cm
- 76 – 100 cm
- 101 – 148 cm

Deadwood (DBH)

- 10 – 25 cm
- 26 – 50 cm
- 51 – 75 cm
- 76 – 100 cm
- 101 – 165 cm

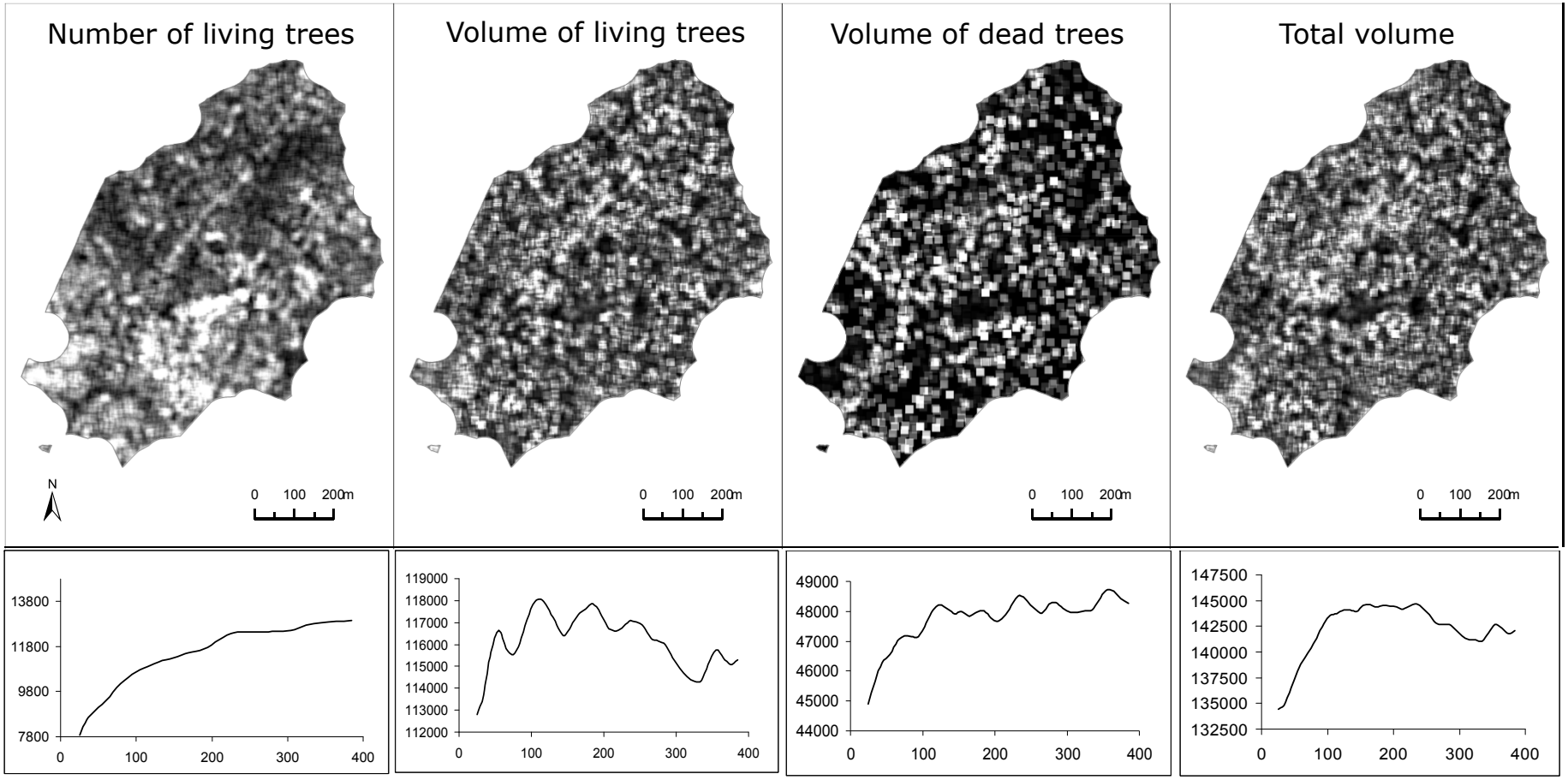
Density:

Max: 1050 pcs/ha

Min: 0 pcs/ha

# High relative nugget (60-95%)
# Low spatial auto-correlation (5-40%)

Feature specific pattern ?




Range:100, 230, +380m
Patches: insignificant
Patch Distance: ---

Range: 105 m
Patches: distinct
Patch Distance: 70 m

Range: 120 m
Patches: dual
Patch Distance: 50-70 m

Range: 105 m
Patches: minor
Patch Distance: 50 m

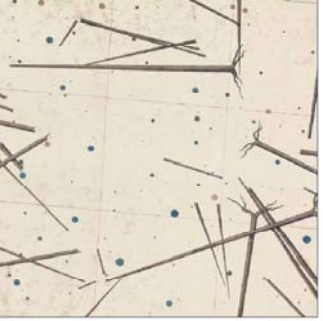
# The minimal number of plots and total sampling area required for estimations of main stand characteristics to within 20% (±10%) of the mean with 95% confidence for various plot sizes.

| Feature | Plot size [m] | 10 × 10 | 20 × 20 | 30 × 30 | 50 × 50 | 70 × 70 | 100 × 100 | 140 × 140 | 200 × 200 |
|---|---|---|---|---|---|---|---|---|---|
| | Plot area [ha] | 0.01 | 0.04 | 0.09 | 0.25 | 0.49 | 1.00 | 1.96 | 4.00 |
| $N_{live}$ | No. of plots | 234 | 96 | 58 | 31 | 21 | 14 | 10 | 7 |
| | *Total sampling area* | *2.34* | *3.84* | *5.22* | *7.75* | *10.29* | *14.00* | *19.60* | *28.00* |
| $V_{total}$ | No. of plots | 251 | 69 | 34 | 15 | 9 | 6 | 4 | 3 |
| | *Total sampling area* | *2.51* | *2.76* | *3.06* | *3.75* | *4.41* | *6.00* | *7.84* | *12.00* |
| $BA_{live}$, $V_{live}$ | No. of plots | 350 | 96 | 46 | 19 | 12 | 7 | 5 | 4 |
| | *Total sampling area* | *3.50* | *3.84* | *4.14* | *4.75* | *5.88* | *7.00* | *9.80* | *16.00* |
| $V_{CWD}$, $R_{CWD}$ | No. of plots | 1272 | 337 | 156 | 60 | 33 | 18 | 11 | 7 |
| | *Total sampling area* | *12.72* | *13.48* | *14.04* | *15.00* | *16.17* | *18.00* | *21.56* | *28.00* |

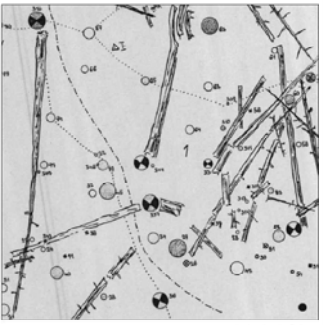
The use of a single or few small preferentially selected plots for the characterization of natural stands may lead to generalizations based on biased or unreliable results in natural forests.

Král K., Janík D., Vrška T., Adam D., Hort L., Unar P., Šamonil P., 2010: Local variability of stand structural features in beech dominated natural forests of Central Europe: implications for sampling. For. Ecol. Manag. 260: 2196-2203.

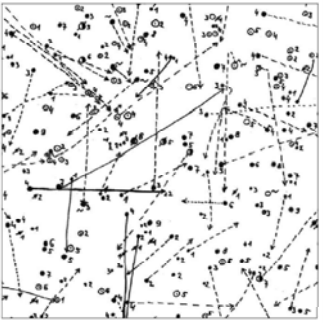
# Tree spatial pattern development



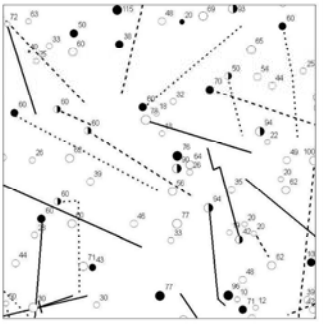
Year of measurement 1851



1961/64



1972



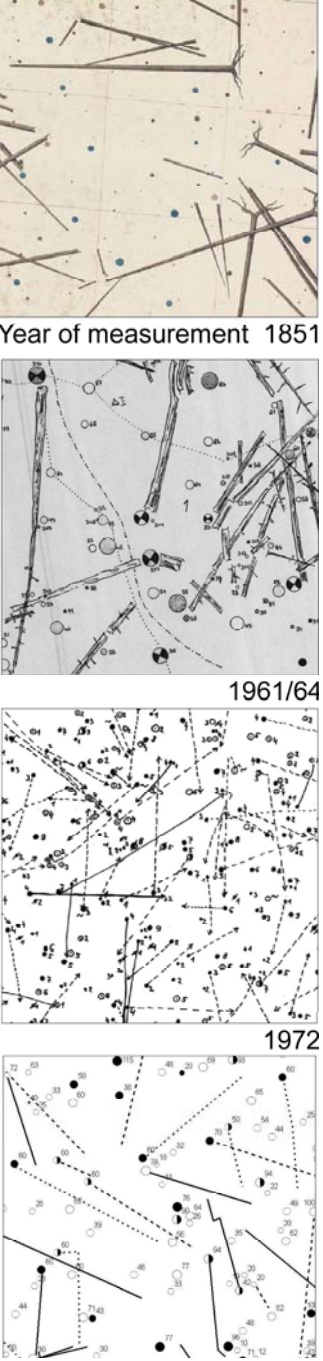
1996, 2010

| Research plot | Year of measurement | All live trees | *Picea abies* | *Fagus sylvatica* | *Abies alba* | *Abies* vs. *Picea* | *Abies* vs. *Fagus* | *Fagus* vs. *Picea* |
|---|---|---|---|---|---|---|---|---|
| I | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | x | | | |
| | 2010 | | | | x | | | |
| II | 1961/64 | | | | x | x | x | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| III | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| IV | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| V | 1851 | | | | | | | |
| Va | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| Vb | 1961/64 | | | | x | x | x | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |

0 15 30 m

clustered distribution | random distribution | regular distribution | x low data

# Tree spatial pattern development




| Research plot | Year of measurement | All live trees | *Picea abies* | *Fagus sylvatica* | *Abies alba* | *Abies* vs. *Picea* | *Abies* vs. *Fagus* | *Fagus* vs. *Picea* |
|---|---|---|---|---|---|---|---|---|
| I | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | x | | | |
| | 2010 | | | | x | | | |
| II | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | | | | |
| | 2010 | | | | | | | |
| III | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | | | | |
| | 2010 | | | | | | | |
| IV | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | | | | |
| | 2010 | | | | | | | |
| V | 1851 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| Vb | 1961/64 | | | | x | x | x | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |

0 15 30 m

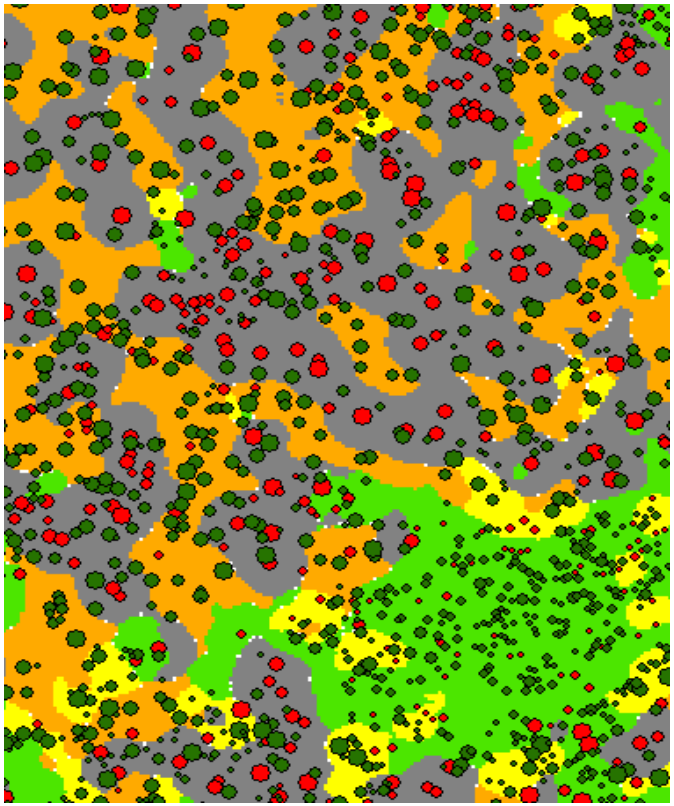
clustered distribution | random distribution | regular distribution | x low data

- A random TSP was most common
- This was generally true even when *Abies alba* was gradually forced out from the stand structure.
- Water-affected plots → higher tendency towards clustering
- Compared with *Fagus sylvatica*, the *Picea abies* pattern was more variable over time
- The only step change in TSP occurred due to storm Emma in 2008.

Šebková, B., Šamonil, P. Janík, D., Adam, D., Král, K., Vrška, T., Hort, L., Unar, P. 2011. Spatial and volume patterns of an unmanaged submontane mixed forest in Central Europe: 160 years of spontaneous dynamics. For. Ecol. Manag. 262: 873-885.

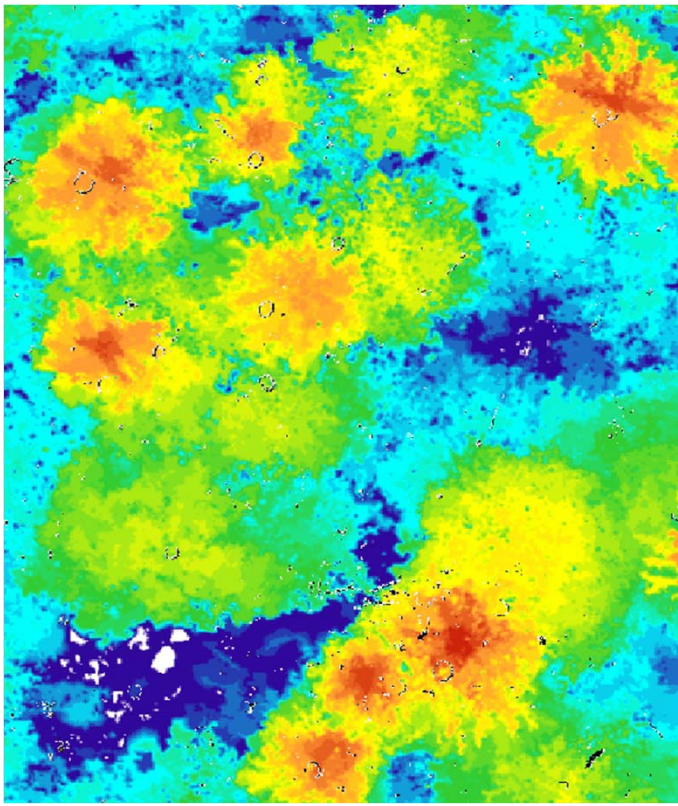
# Theory for developmental cycles and gap dynamics – coupling of approaches

Exact determination of developmental stages



×

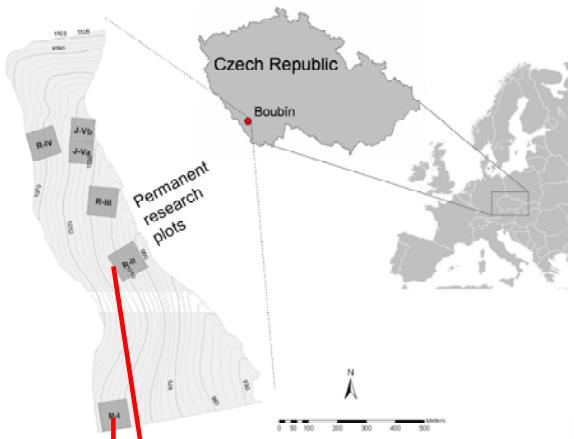
Terrestrial laser scanning



Kenderes K., Král K., Vrška T., Standovar T., 2009. Natural gap dynamics in a Central European mixed beech-spruce-fir old-growth forest. Ecoscience 16 (1): 39-47.

# Trvalost a specifičnost objemové a prostorová struktury lesa

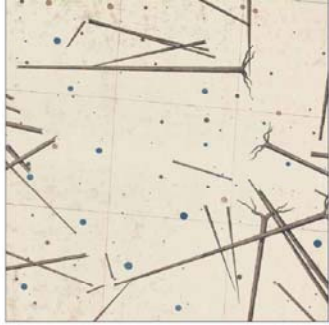
## Tree spatial pattern



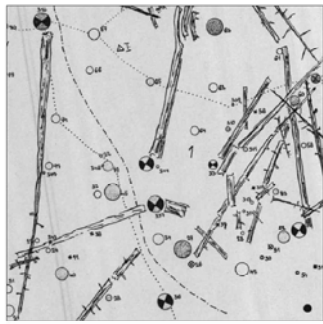

| Research plot | Year of measurement | All live trees | *Picea abies* | *Fagus sylvatica* | *Abies alba* | *Abies* vs. *Picea* | *Abies* vs. *Fagus* | *Fagus* vs. *Picea* |
|---|---|---|---|---|---|---|---|---|
| I | 1961/64 | | | | | | | |
| | 1972 | | | | | | | |
| | 1996 | | | | x | | | |
| | 2010 | | | | x | | | |
| II | 1961/64 | | | | x | x | x | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| III | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| IV | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| V | 1851 | | | | | | | |
| Va | 1961/64 | | | | | | | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |
| Vb | 1961/64 | | | | x | x | x | |
| | 1972 | | | | x | | | |
| | 1996 | | | | x | x | x | |
| | 2010 | | | | x | x | x | |

0 15 30 m

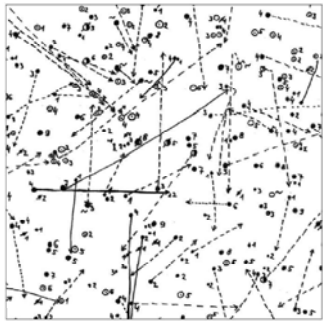
clustered distribution | random distribution | regular distribution | x low data



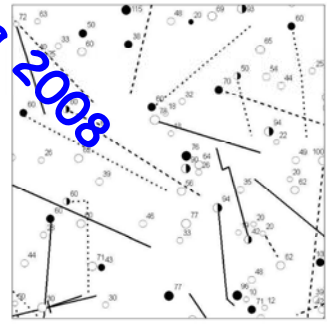
Year of measurement 1851



1961/64

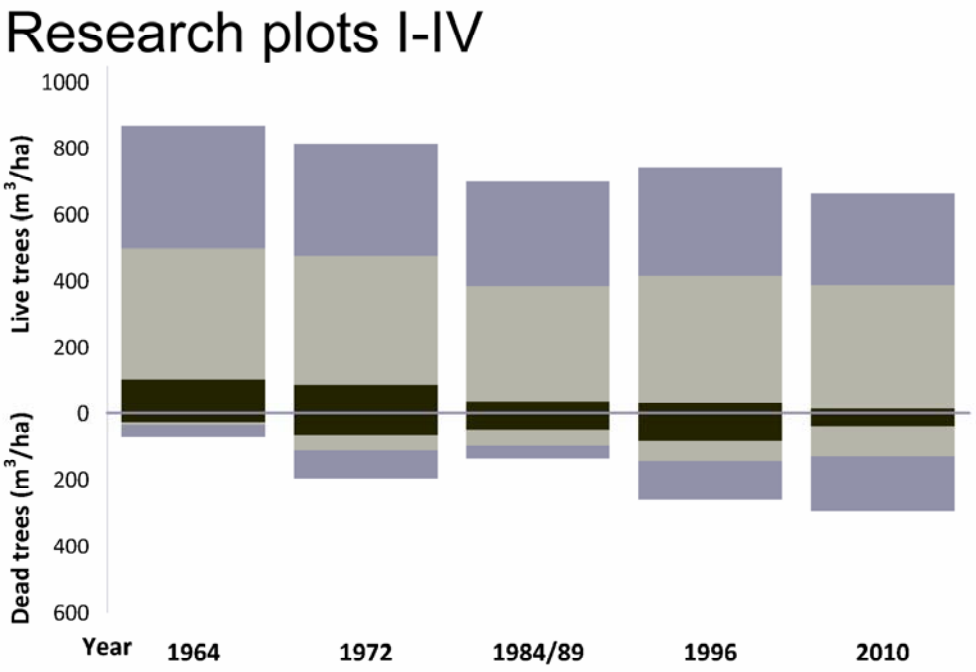


1972



1996, 2010

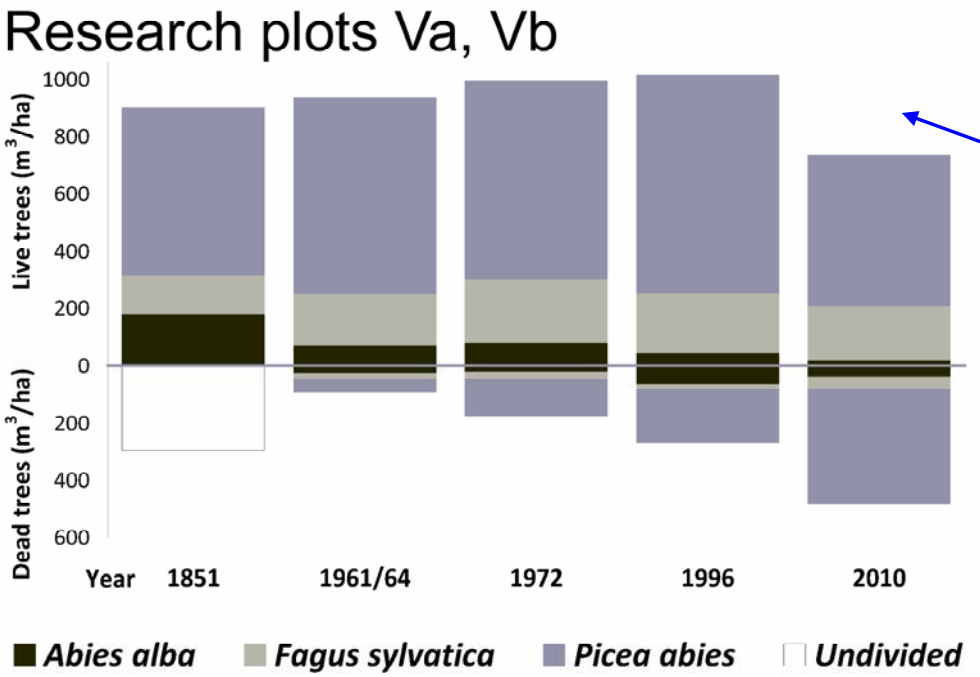
Emma 2008




# Objem

Při absenci rozsáhlých disturbancí se celkový objem liší o 5-(10)%

Vnitřní struktura se ale velmi mění (záměna dřevin aj.)

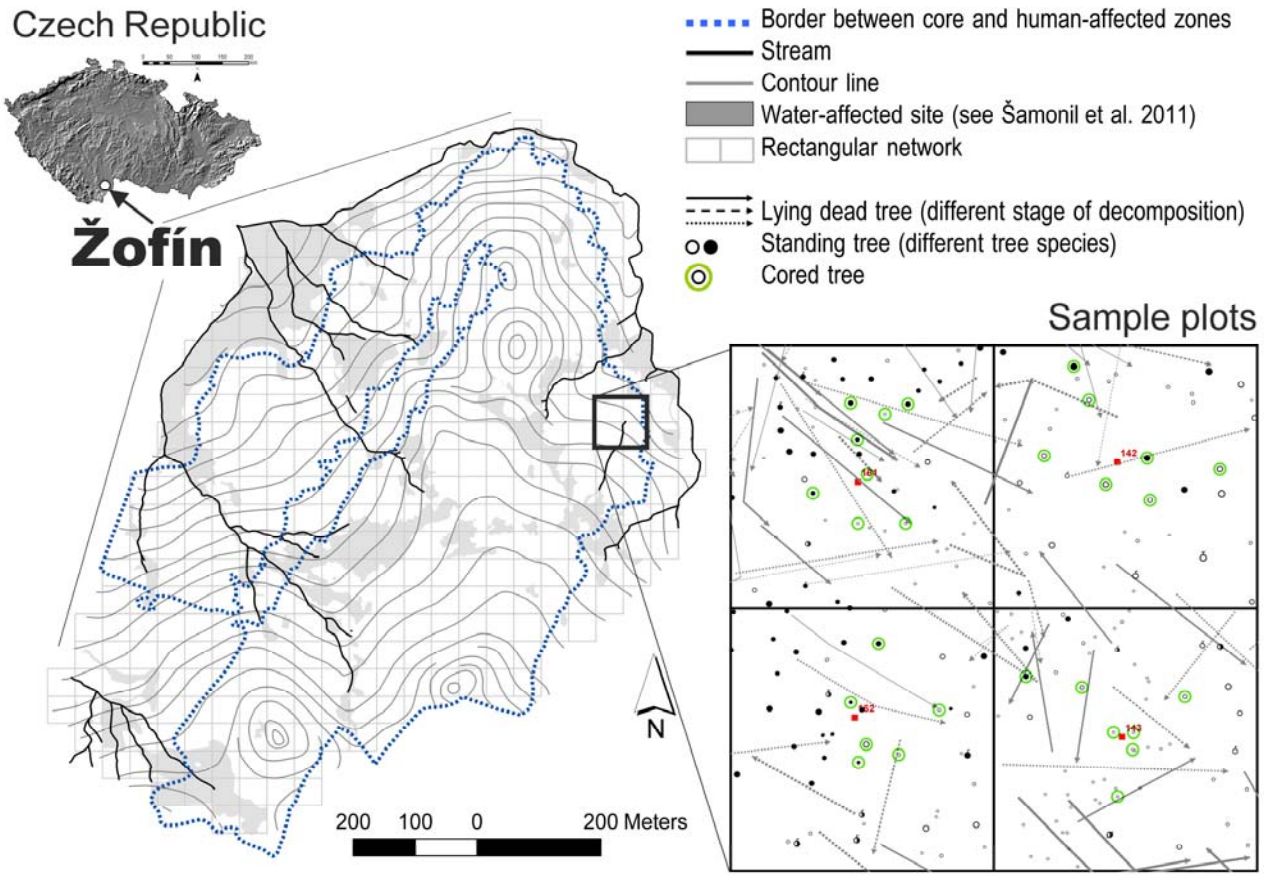



Emma 2008

# Výstupy:

Šamonil P., Doleželová P., Vašíčková I., Adam D., Valtera M., Král K., Janík D., Šebková B., Hort L. *under review*. Individual-based approach to detection of disturbance history through spatial scales in natural beech-dominated forest. Journal of Vegetation Science.

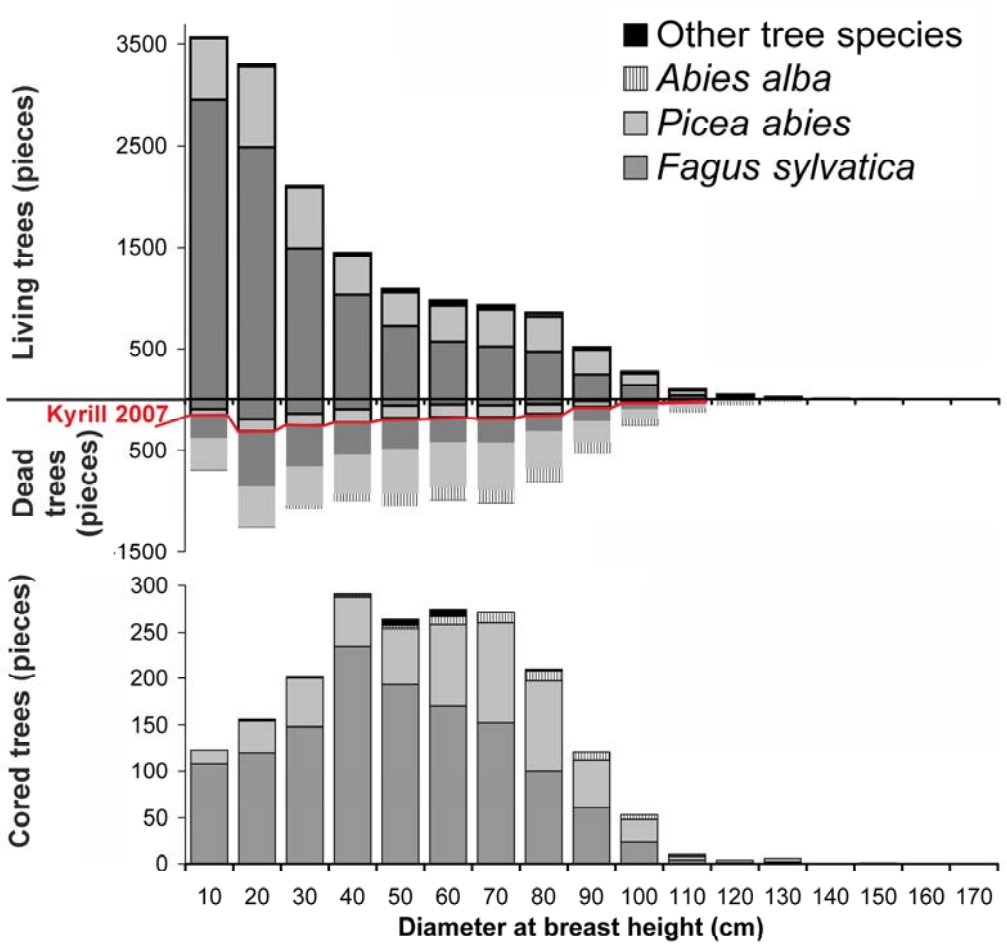
Jak aplikovat individual-based spatially explicit model napříč prostorovými škálami?
Jaká je disturbanční historie SM-JD-BK pralesa a jaký byl vliv člověka?
Jak odpovídá dendrochronologický záznam disturbanční historie skutečným událostem?



# Silné větry v minulosti

## Struktura porostu

## Struktura vrtaných stromů



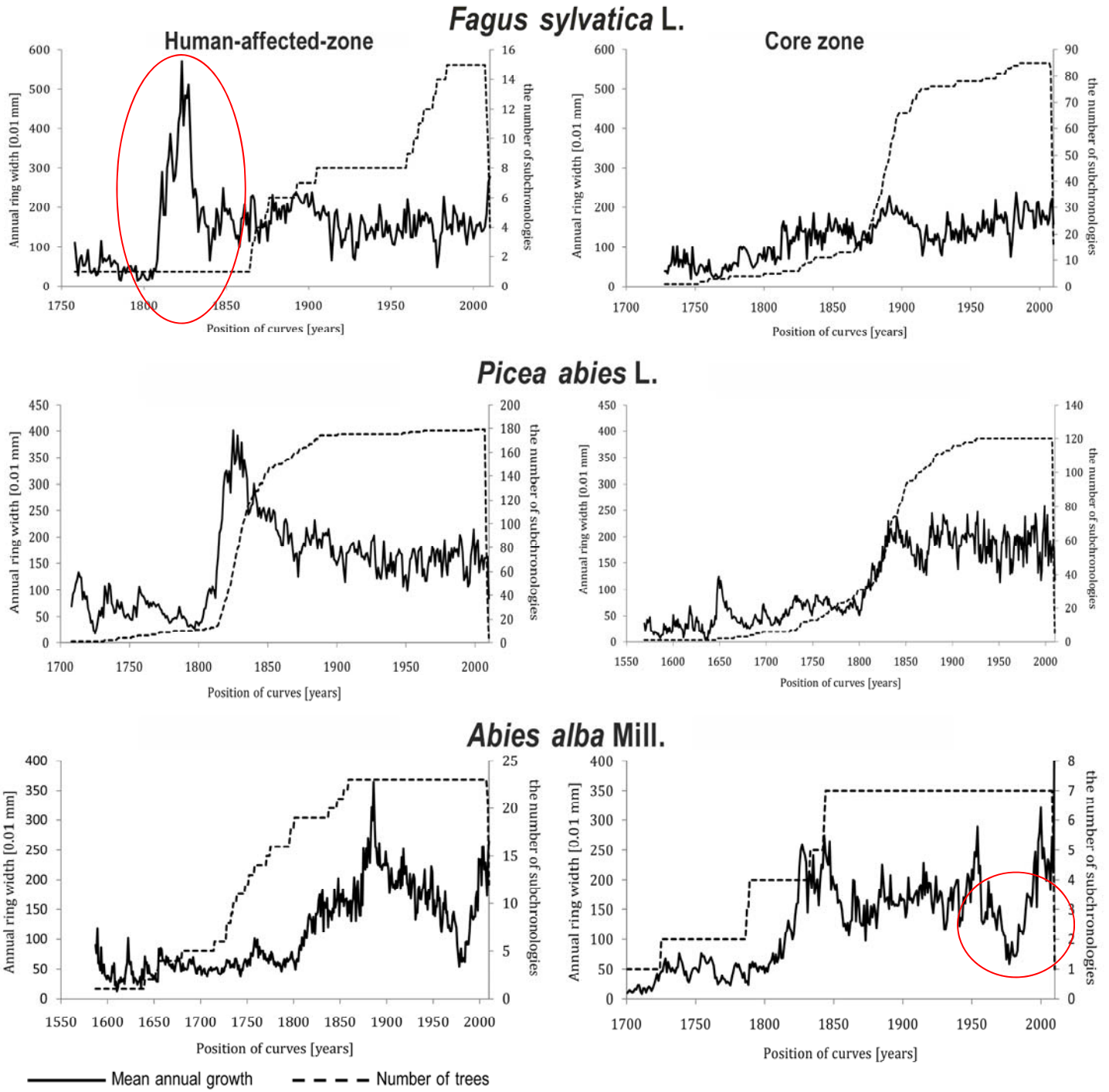
# Průměrný růst stromů

Propad v 80. letech

Vliv člověka od 1800

Neodpovídá klimatickým datům

Falešná uvolnění v 90. letech



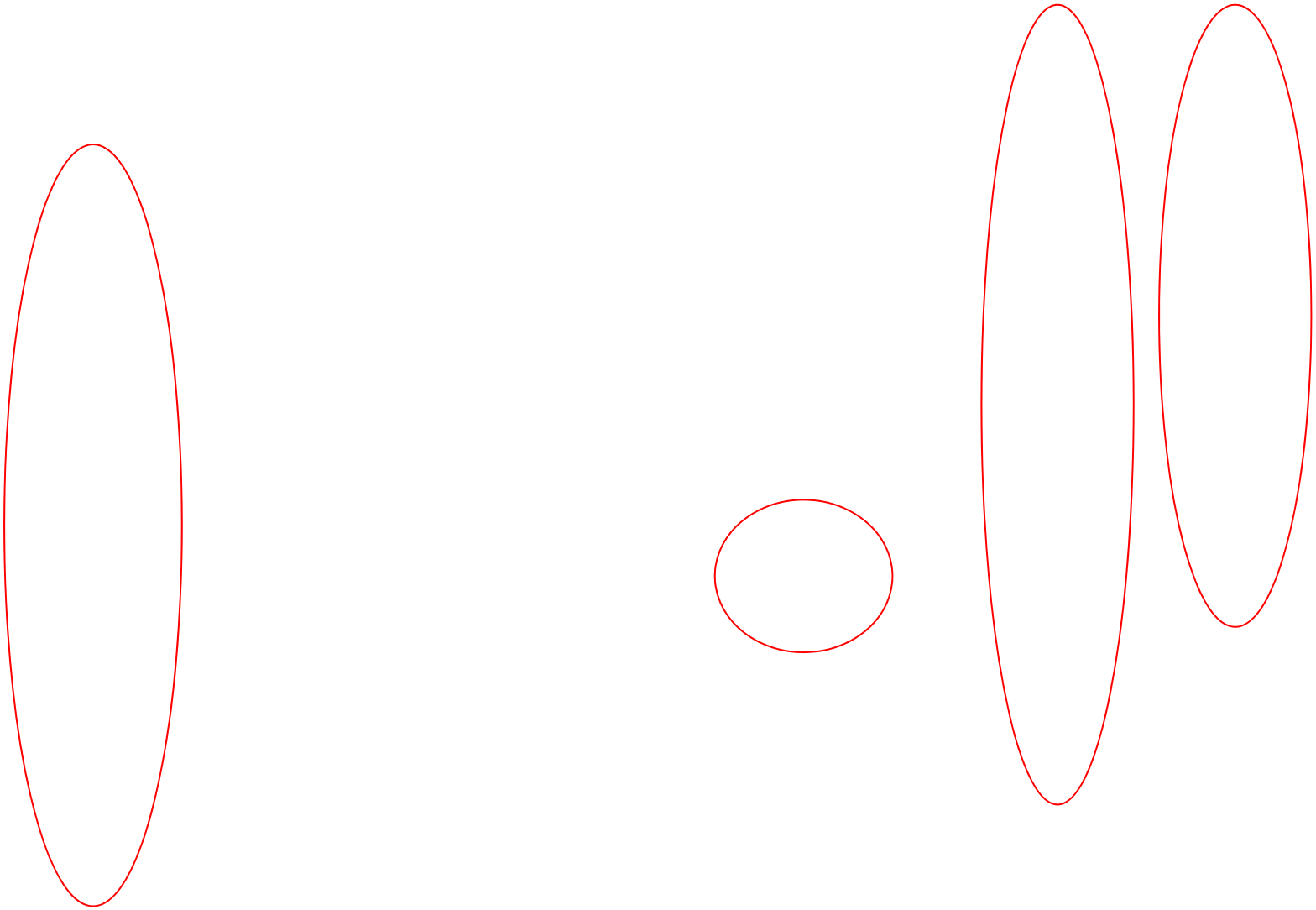
**Disturbanční historie v dendrometrických datech**

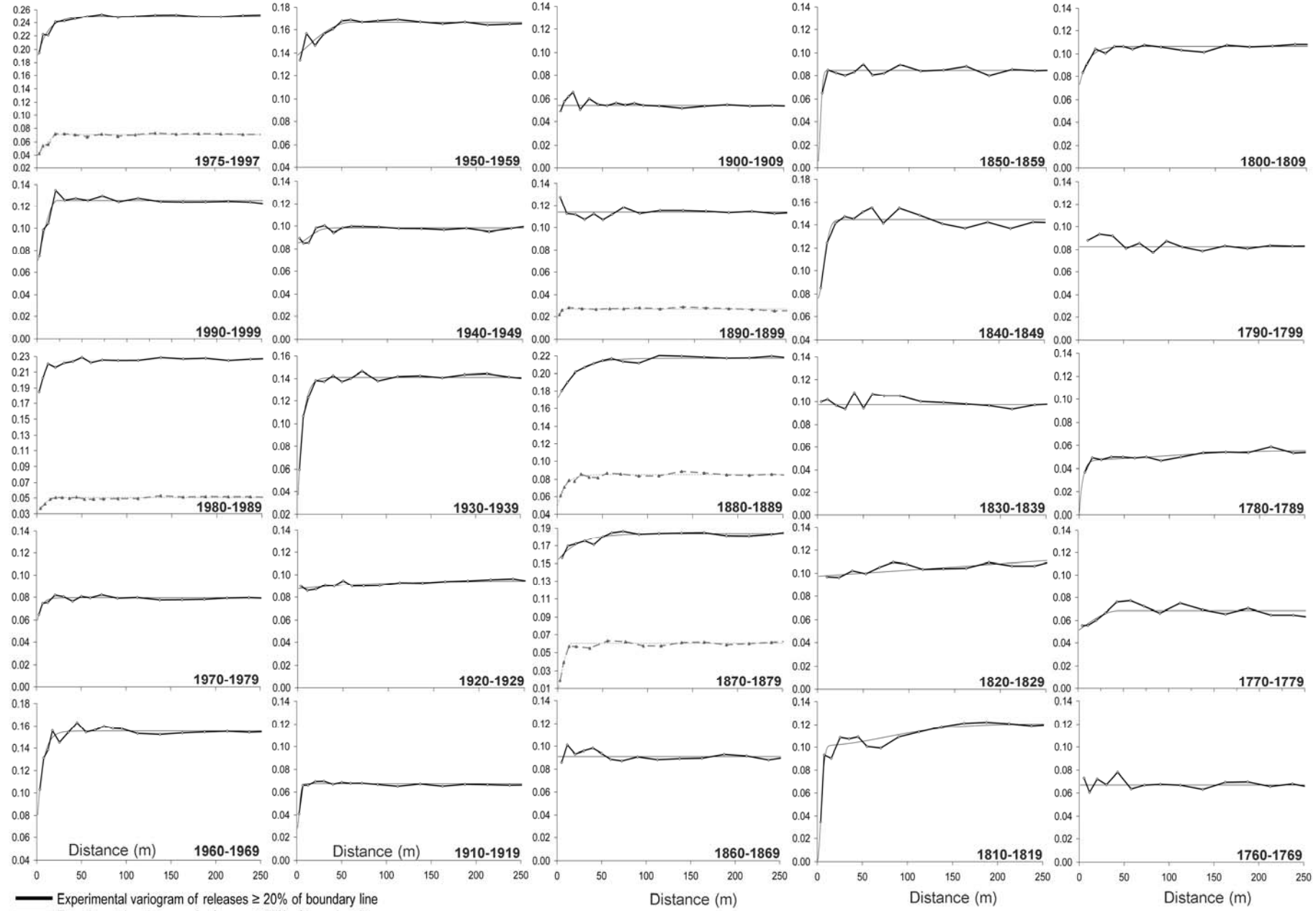
**1975-2008**

(= reálné disturbance)

Kyrill z 18.-19. 1. 2007 byl unikátní z hlediska spatial pattern, nikoli intenzity - range až 320 m, jinak do 30 m.

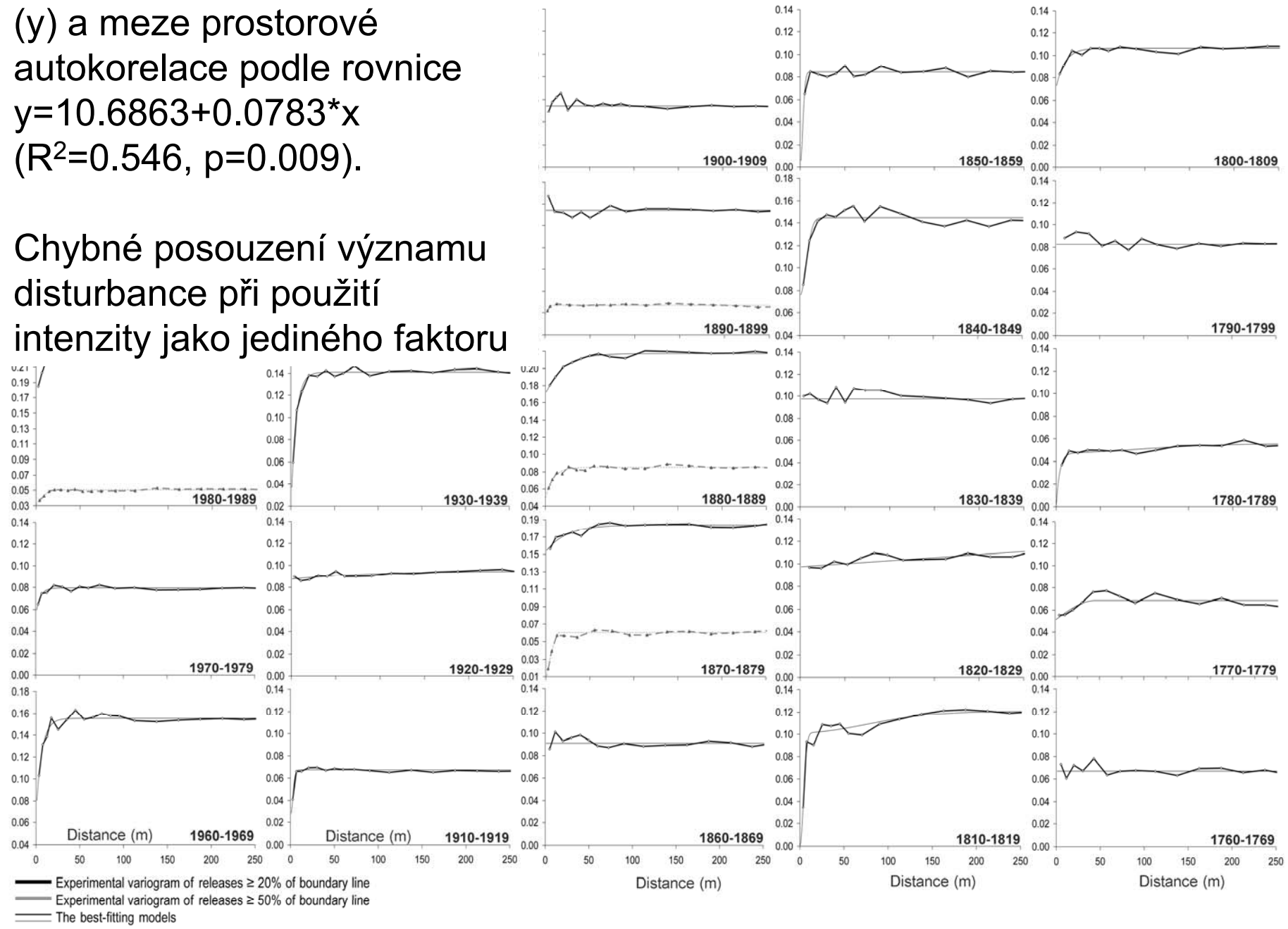
# Disturbanční historie v dendrochronologických datech 1650-1999, + komparace s reálnými disturbancemi 1975-1997




1975-1997
1950-1959
1900-1909
1850-1859
1800-1809
1990-1999
1940-1949
1890-1899
1840-1849
1790-1799
1980-1989
1930-1939
1880-1889
1830-1839
1780-1789
1970-1979
1920-1929
1870-1879
1820-1829
1770-1779
1960-1969
1910-1919
1860-1869
1810-1819
1760-1769
Distance (m)
Experimental variogram of releases ≥ 20% of boundary line
Experimental variogram of releases ≥ 50% of boundary line
The best-fitting models

Vztah disturbanční intenzity (y) a meze prostorové autokorelace podle rovnice y=10.6863+0.0783*x ($R^2$=0.546, p=0.009).

Chybné posouzení významu disturbance při použití intenzity jako jediného faktoru



# Počet disturbančních událostí v dendrochronologickém záznamu

pulzující gapy
vs.
dlouhodobé gapy
(+ edafické)

Historická a
geografická
kontingence