Natural regeneration in the area after bark beetle calamity in the Beskidy Mountains (Poland)

Tadeusz Zachara[1], Sławomir Ambroży[2]

Forest Research Institute, Department of Silviculture and Forest Genetics, Sękocin Stary[1]

Forest Research Institute, Department of Mountain Forests, Kraków[2]

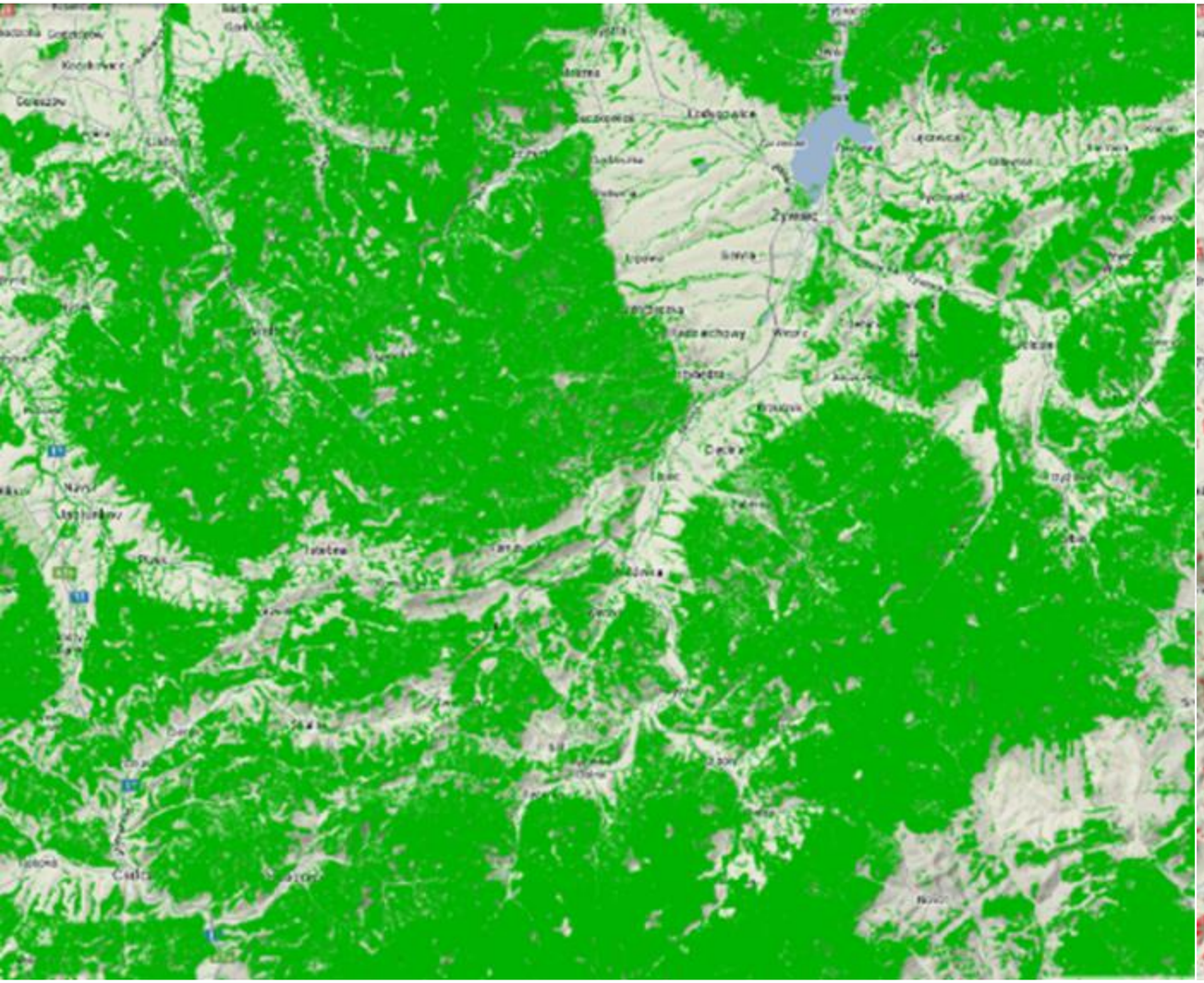
e-mail: T.Zachara@ibles.waw.pl; S.Ambrozy@ibles.waw.pl

Location

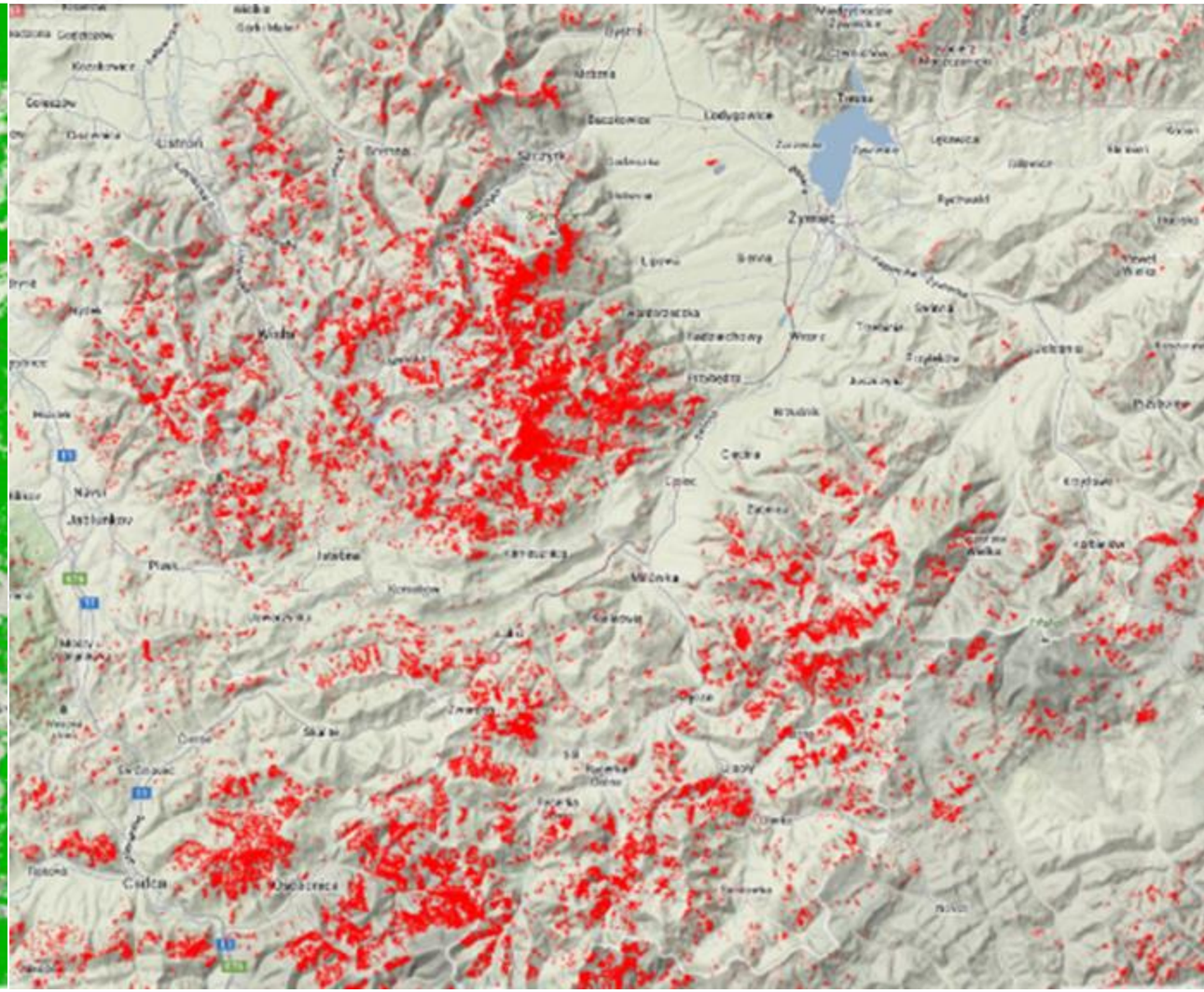
At the turn of the 20th and 21st centuries large-scale decline of Norway spruce artificial stands occurred in the Western Beskidy Mountains, mainly caused by bark beetle outbreak.

Deforested areas

Forests in the Western Beskidy Mountains

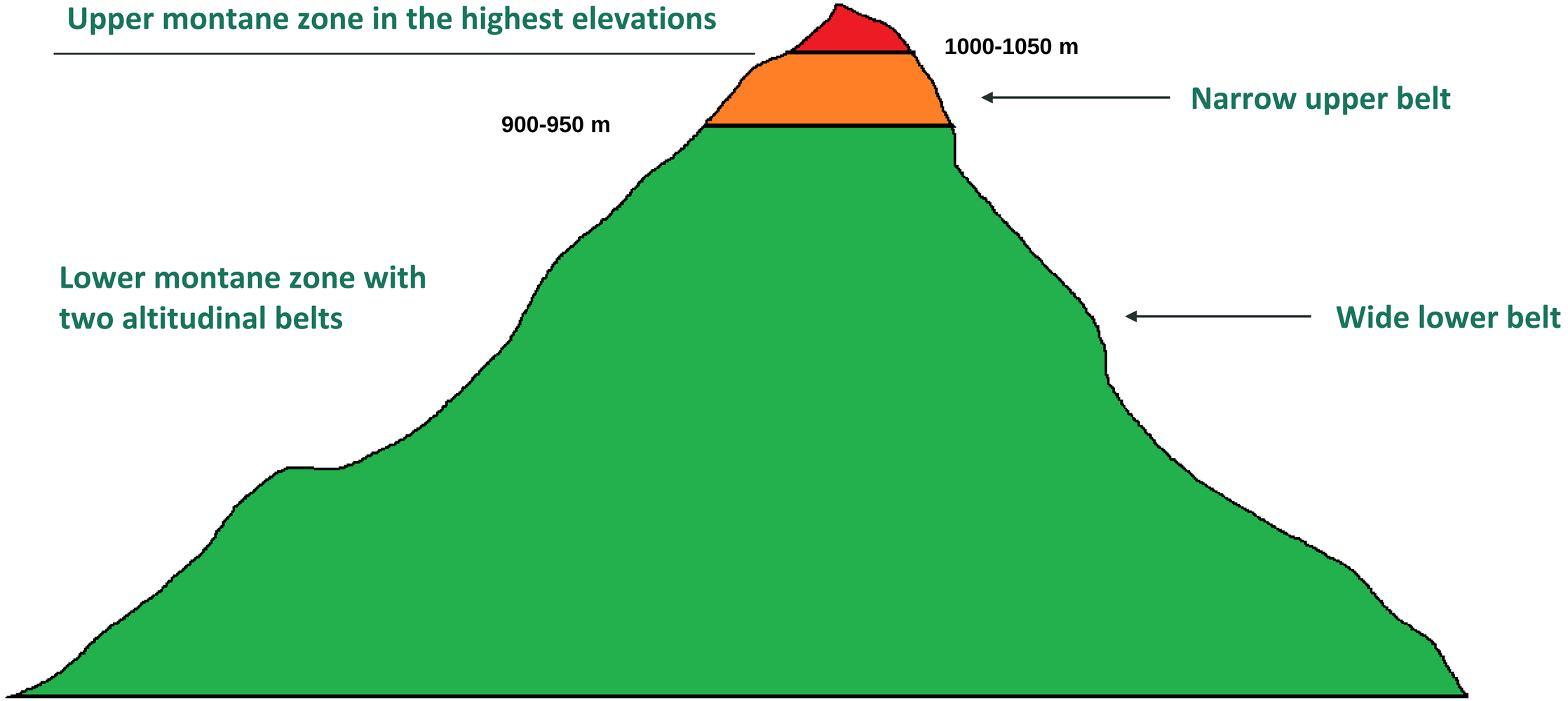


Deforested areas in the Western Beskidy Mountains (approx. 14.5 thousand ha)



Sites conditions

Altitudinal range



Upper montane zone

Climatic conditions make the upper montane zone a site only for spruce forests

Lower montane zone – upper belt

Sites of upper belt are appropriate for spruce forests with a small admixture of other species (mainly beech and fir)

Lower montane zone – lower belt

Fertile sites of lower belt are appropriate for broadleaved and mixed broadleaved forests

Natural regeneration - European rowan

Natural regeneration of European rowan occurs mainly in the upper montane zone and the upper belt of lower montane zone

Natural regeneration - silver birch

Natural regeneration of silver birch occurs mainly in the lower belt of lower montane zone

Natural regeneration - Norway spruce

Natural regeneration of Norway spruce is very expansive and is present in in the whole altitudinal range of deforested areas in the Western Beskidy Mountains

Disadvantages of natural regeneration

Species composition of natural regeneration is usually different from the target species composition, appropriate for sites diversity.

Only in the upper montane zone and upper belt of lower montane zone, natural regeneration of Norway spruce is appropriate for site conditions.

Advantages of natural regeneration

The advantage of natural regeneration is:

- limit the expansion of weeds covering the soil (reed grass *Calamagrostis arundinacea* (L.) Roth, bilberry *Vaccinium myrtillus* L.

- create conditions suitable for planting target trees species, mainly European beech *Fagus sylvatica* L. and silver fir *Abies alba* Mill.


Calamagrostis arundinacea


Vaccinium myrtillus

Damage to natural regeneration

The most important are damages caused by abiotic factors in spruce regeneration.

The damages caused by biotic factors in spruce and other species regeneration were much less important .

Damage to natural regeneration

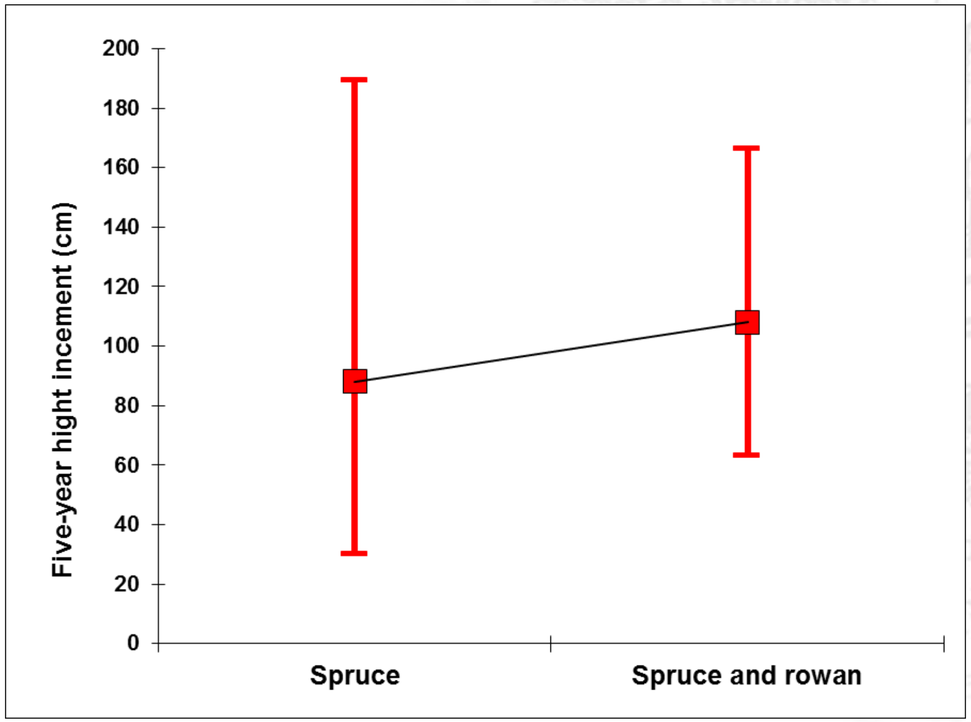
Norway spruce branches and steams damage caused by snow or rime

Damage to planting regeneration of target species

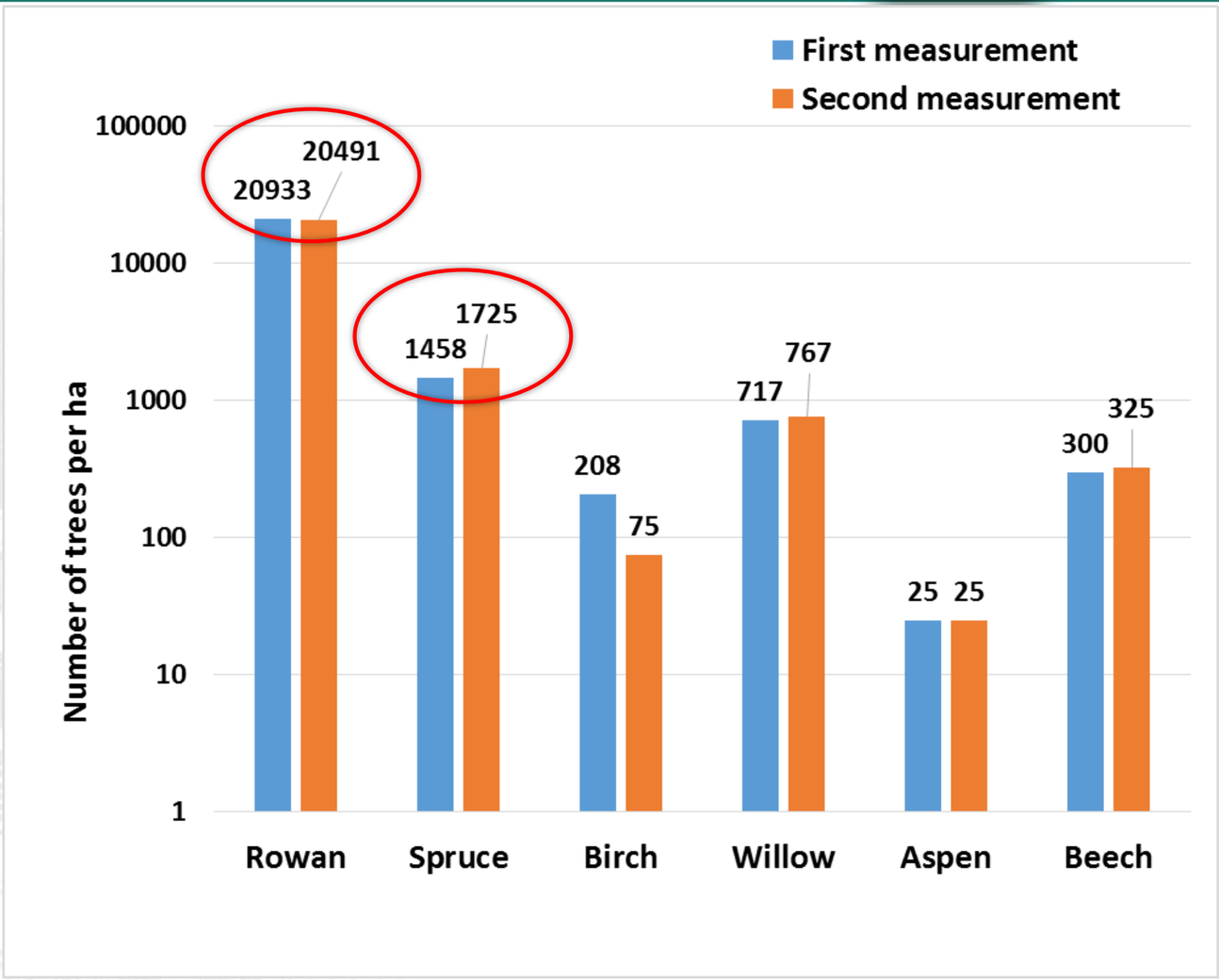
The most important are damages caused by deer

European rowan

The presence of European rowan regeneration supports the initiation and development of spruce regeneration.



Comparison of five-year height increment in spruce regeneration without rowan cover and with rowan cover



Presented on a logarithmic scale changes in the number of trees by species in regeneration on the research plot, determined on the basis of two consecutive measurements taken in two years interval

European rowan

Silviculture recommendations:

- As long as possible, keep rowan as a cover for other species regeneration.

- Keep low density of spruce undergrowth, in order to shape more resistant trees with long and strong crowns.

- Additionally, in the upper belt of lower montane zone, plant target admixture species (with up to 20% share) and restrict competition from spruce in relation to them.

Norway spruce

Silviculture recommendations:

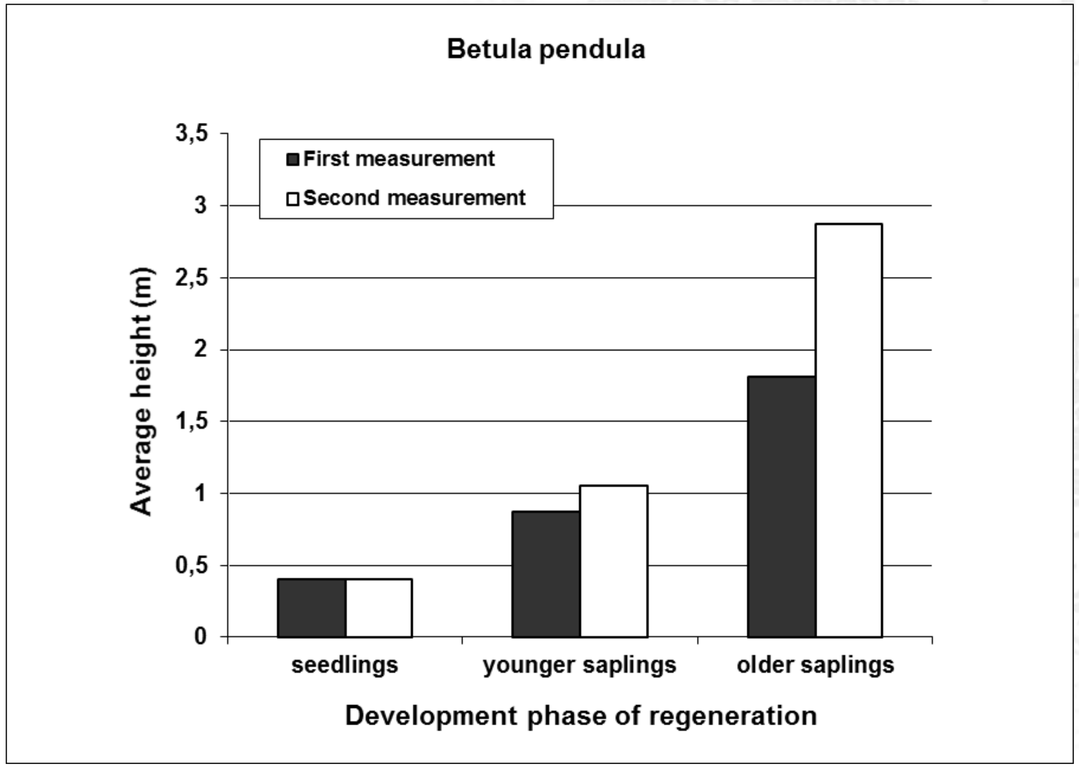
- In the upper montane zone and the upper belt of lower montane zone the silviculture recommendations are the same as for spruce undergrowth with rowan
- In the lower belt of lower montane zone is necessary to carry out a consistent conversion of spruce regeneration into target species, whose share should reach over 50%
- It is also necessary to limit the competition of spruce in relation to planted species

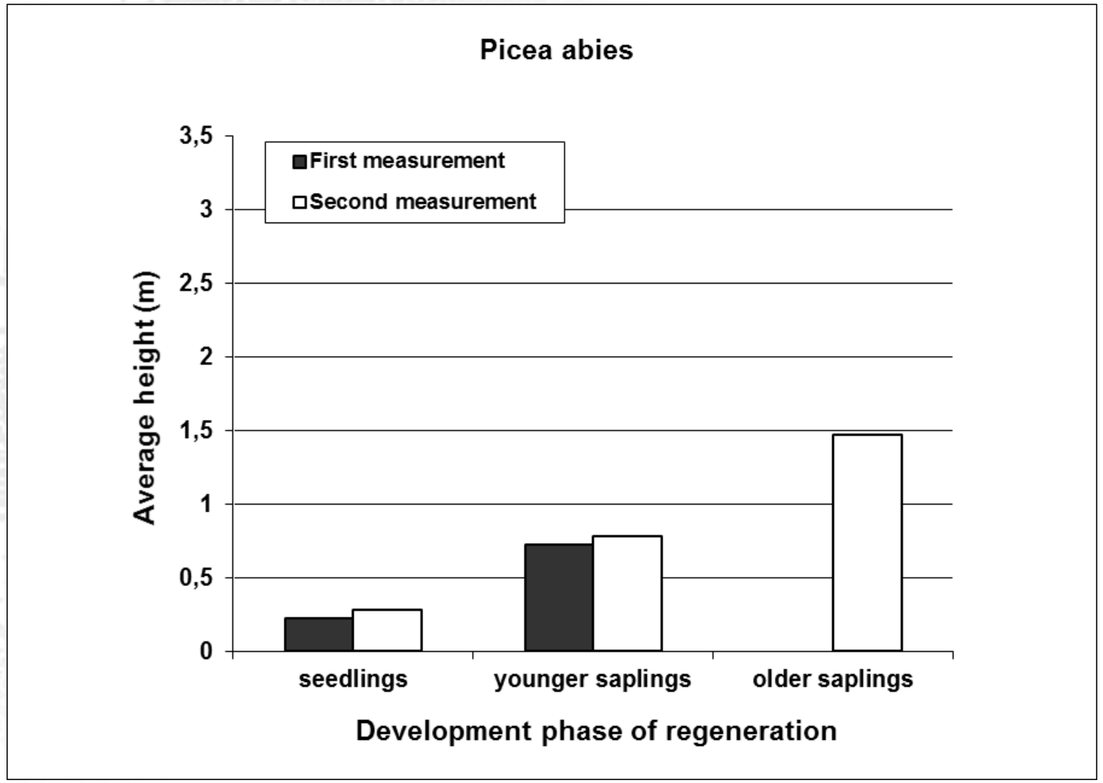
Beech dominated by spruces

Silver birch

Silviculture recommendations:

- **It is recommended to introduce target species as early as possible, when the regeneration of birch are aged 5 - 6 years**

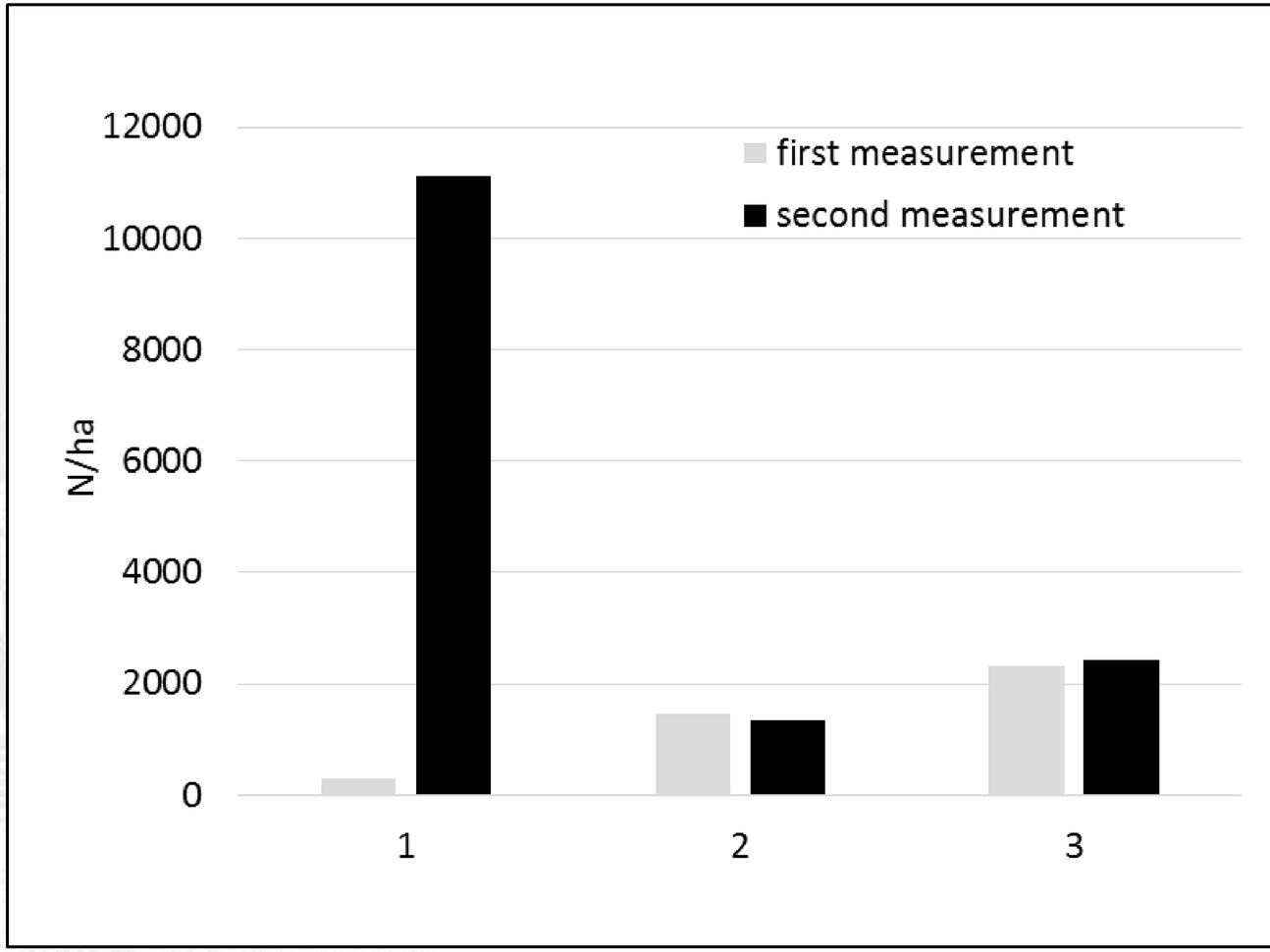




The average height of birch and spruce regenerations in development phases, identified on the basis of two consecutive measurements taken at an interval of one year

Silver birch - silviculture recommendations:

- **Cutting all the birches in a large area results in the rapid growth of stump sprouts, which particularly threatens the young regeneration of other species, resulting in the need to remove the sprouts at intervals not exceeding two years.**



Changes in the number of birch regeneration not reaching DBH heights and with DBH less than 2 cm (inventory repeated after two years): 1 – 100% of birch clear cut, 2 – 50% of birch cut, 3 – no cuts

Silver birch - silviculture recommendations

The development of birch stump sprouts two years after birch cutting on the experimental plot

Silver birch - silviculture recommendations:

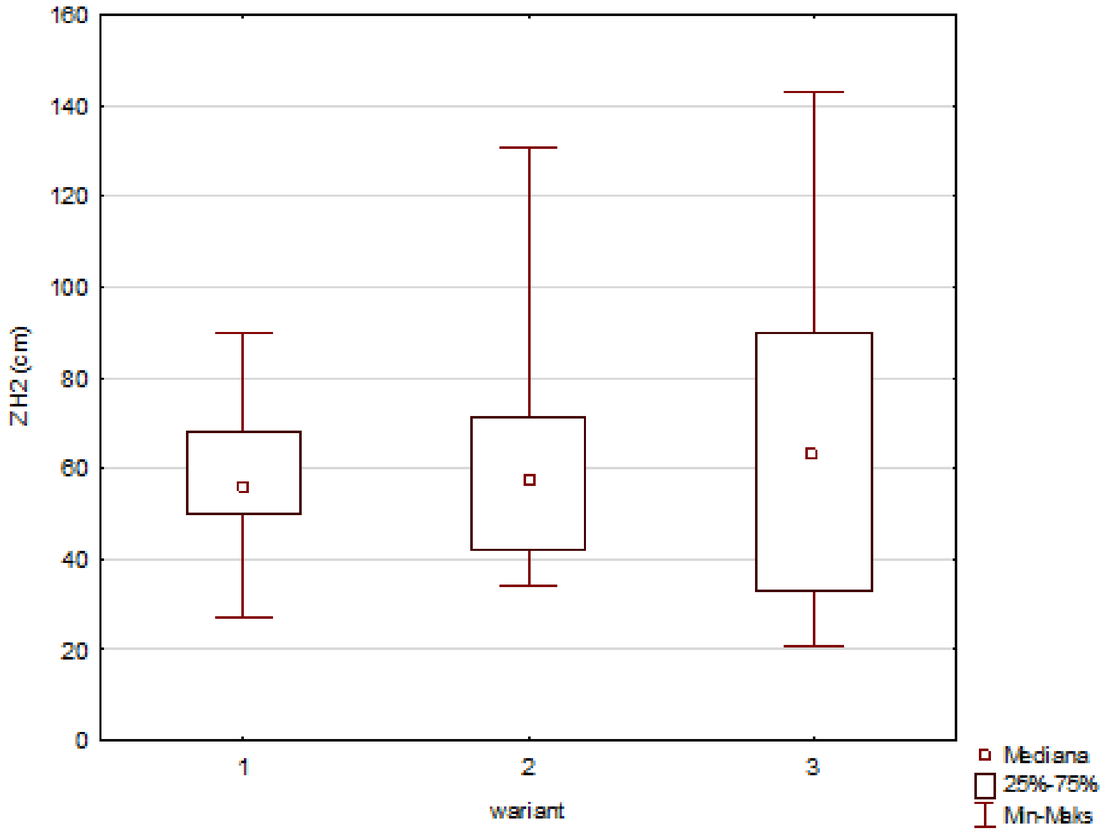
- In order to limit the development of stump sprouts, moderate cuts in birch regeneration should be made and the number of cut birches in the treated area should not exceed 50% of the initial state.

- The cuts should be made first in those areas having the best developed regeneration of target species growing under the canopy, to avoid damage caused by the trees rubbing together.

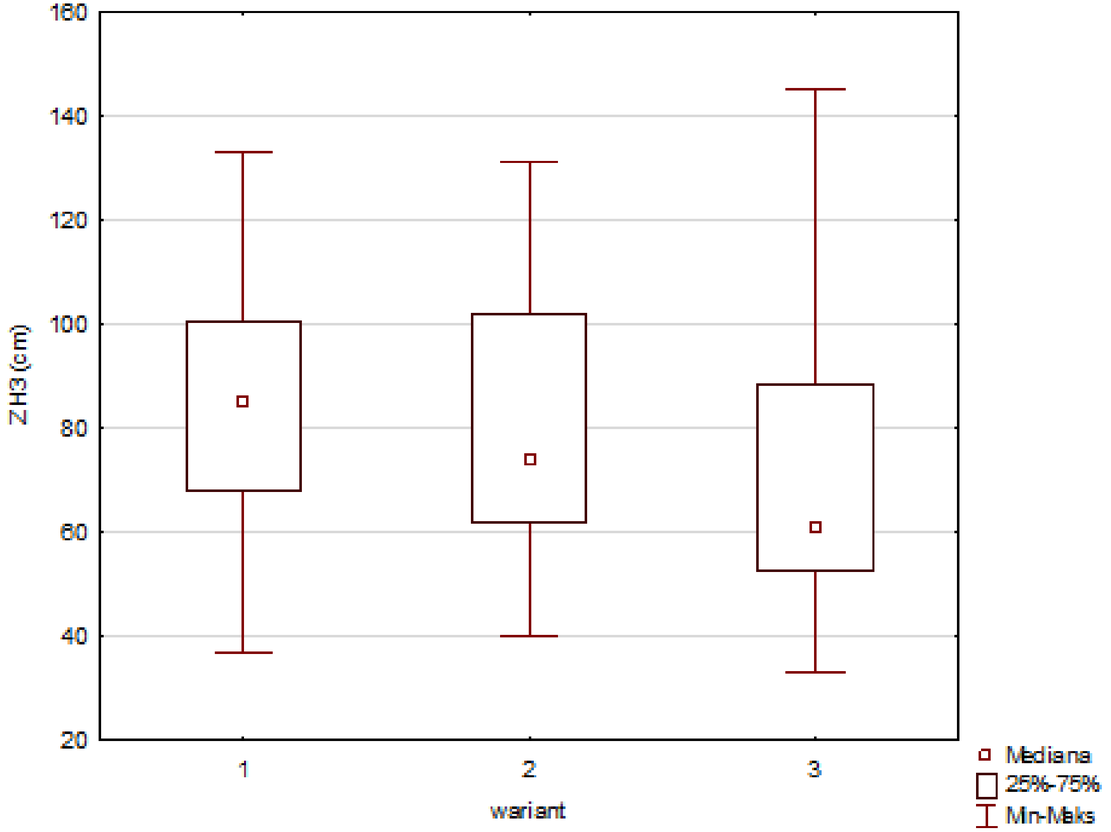
Dead top of the spruce

Silver birch - silviculture recommendations

- **The long-term height increment of spruces under a birch canopy can be significantly lower than the height increment achieved in open spaces. In rich habitats, spruces growing under the canopy may be more resistant to weather-related damage in the future**



Two-year spruce height increment depending on the quantity of birch forecrop left: 1 – 100% of birch clear cut, 2 – 50% of birch cut, 3 – no cuts **(no significant differences)** Kruskal-Wallis test ($p = 0.9454$), $\alpha = 0.05$



Three-year spruce height increment depending on the quantity of birch forecrop left: 1 – 100% of birch clear cut, 2 – 50% of birch cut, 3 – no cuts **(significant differences between 1 and 3)** Kruskal-Wallis test ($p = 0.0006$), $\alpha = 0.05$

Silver birch - silviculture recommendations

- **The target species introduced under cannopy of silver birch need effective protection against damages caused by deer**

Conclusions

- It is necessary to control the species composition of regeneration, to shape stands more resistant to stress and stable, adapted to the site conditions.

- Treatments carried out should fulfill a number of specific requirements, among other such as: maintaining forest cover protective function, supporting target species, shaping spatial structure of regeneration, shaping resistance of trees to damaging agents (mainly atmospheric factors), adjusting interactions between tree species.

- Under these conditions, achieving target species compositions of high stability stands is a multi-stage and long-term task.

References

Ambroży S. [1], Niemtur S. [1], Zachara T. [2] 2015: Ecological and silvicultural methods of managing forest disaster areas (abstract). In: Sierota Z. (ed.) Challenges and Opportunities for 21st-Century Forestry. An International Scientific Conference marking the 85th anniversary of the founding of the Forest Research Institute, 112-113.

Ambroży S. [1], Zachara T. [2], Kapsa M. [1], Chomicz-Zegar E. [1], Vytseha R. [3] 2017: Ways to use silver birch *Betula pendula* Roth regeneration in sites considered for stand conversion due to decline of Norway spruce *Picea abies* (L.) H. Karst. in the Silesian Beskid Mountains

Forest Research Institute, [1]Department of Mountain Forests, ul. Fredry 39, 30-605 Kraków;
[2]Department of Silviculture and Forest Genetics, Sękocin Stary, ul. Braci leśnej 3 , 05-090 Raszyn;
[3] Ukrainian National Forestry University, Forest Inventory Department, Lviv


Thank you for attention