International workshop in southern Sweden, May 2-3 2017

Oak trees in conifer-dominated forest

Seeing the oakscape beyond the forest

how do we use the oak regeneration strategy in land management and conservation?

by Andrzej Bobiec

University of Rzeszów
Faculty of Biology and Agriculture

Acknowledgements

- K. Pilch, J. Franków, M. Korol, S. Havrylyuk, V. Dychkevych contributed to wood sampling and tree ring measurement
- M. Korol, S. Havrylyuk, V. Dychkevych, K. Pilch, J. Franków, J. Pociask, T. Dudek, K. Hulinka, P. Zduńczyk, K. Borycka contributed to stands Field-Map(ing)
- Advice and consultation: K. Öllerer and A. Reif
- Financial support was received through the projects 'Oak woods in rural landscapes of the Carpathian region: origin, dynamics and conservation values', financed by the National Science Centre, Poland, following the decision DEC-2013/11/B/NZ9/00793, and 'The structure of oak population in the strict protection zone of the Białowieża Forest as a result of stands regeneration dynamics during the last 500 years' financed by the Polish Ministry of Science and Higher Education, project no. N N309 295534 (BNP data)

Content

- Oaks (Quercus robur and Q. petraea) distribution and ecological range;
- Oaks status in natural forests – lesson from Białowieża;
- Oakscape: the proper perspective;
- Practical implications

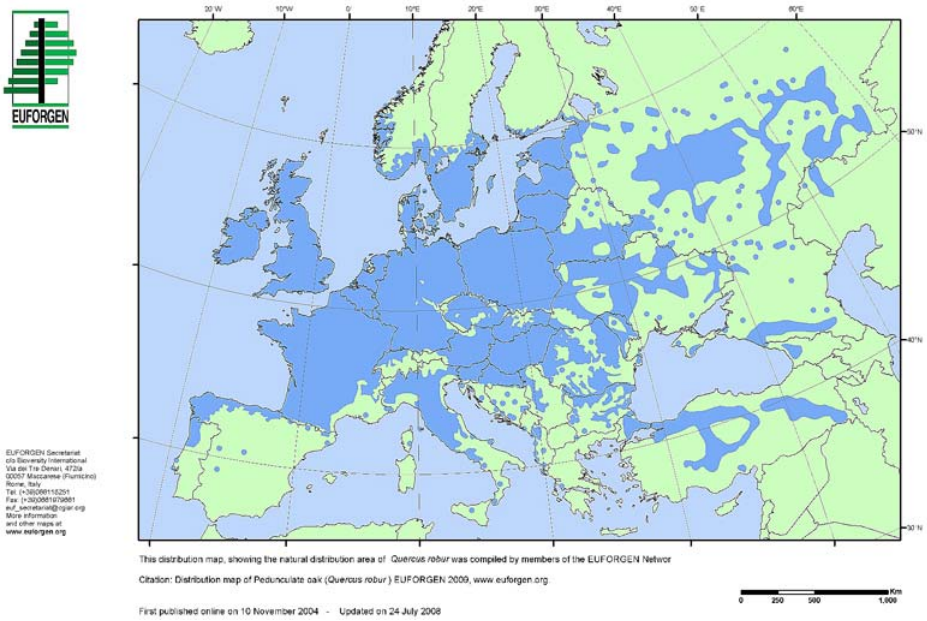
What makes oaks occurring in a phytocenosis?

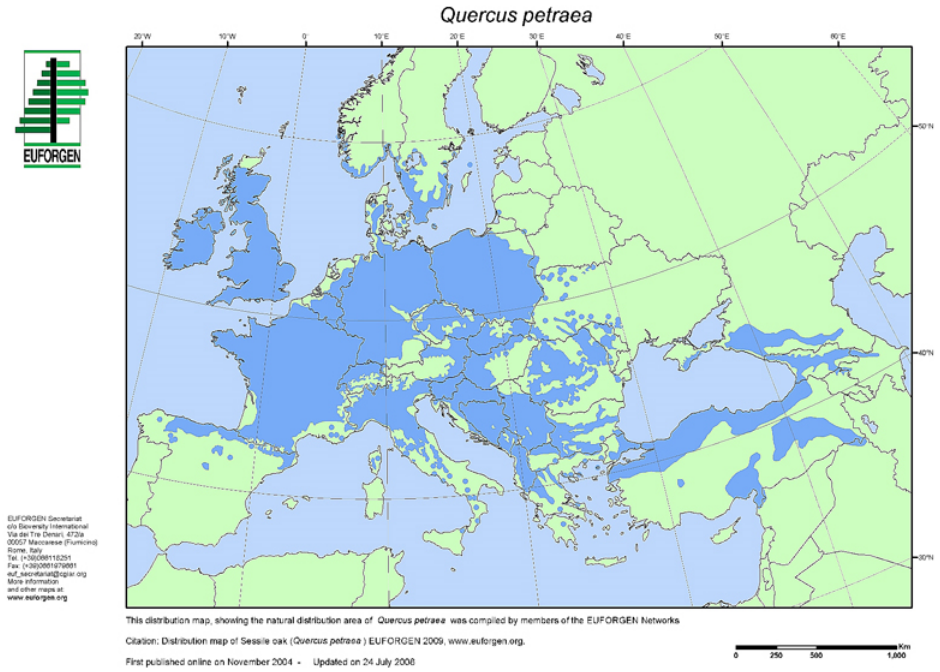
Dispersion, colonization history, physical, geographic barriers

↓

Geographic range

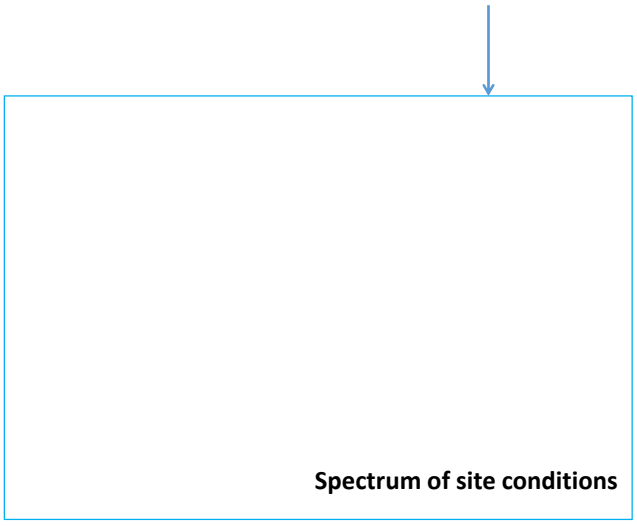
Quercus robur

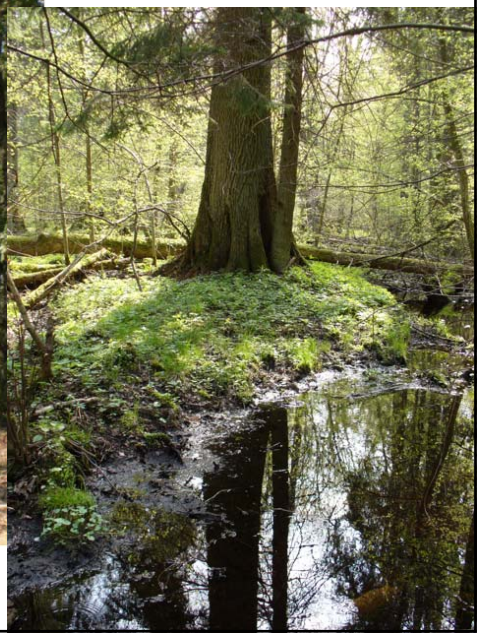




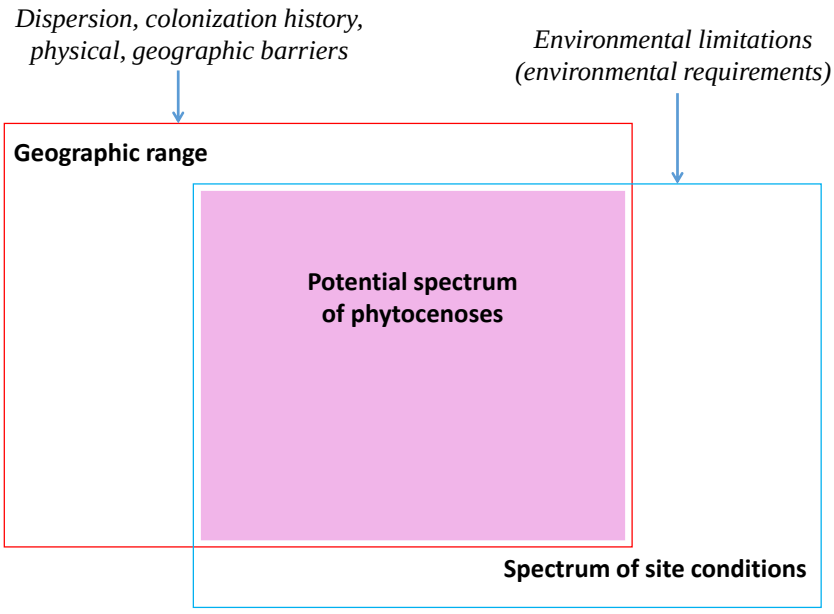
What makes oaks occurring in a phytocenosis?

Environmental limitations
(environmental requirements)

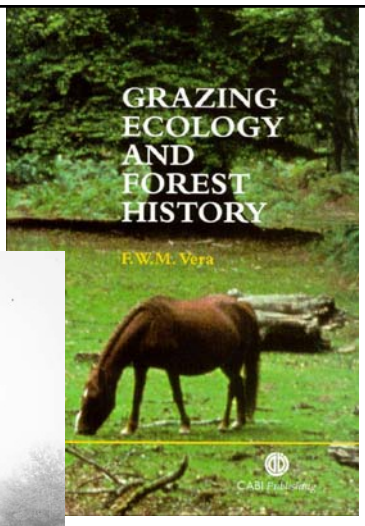




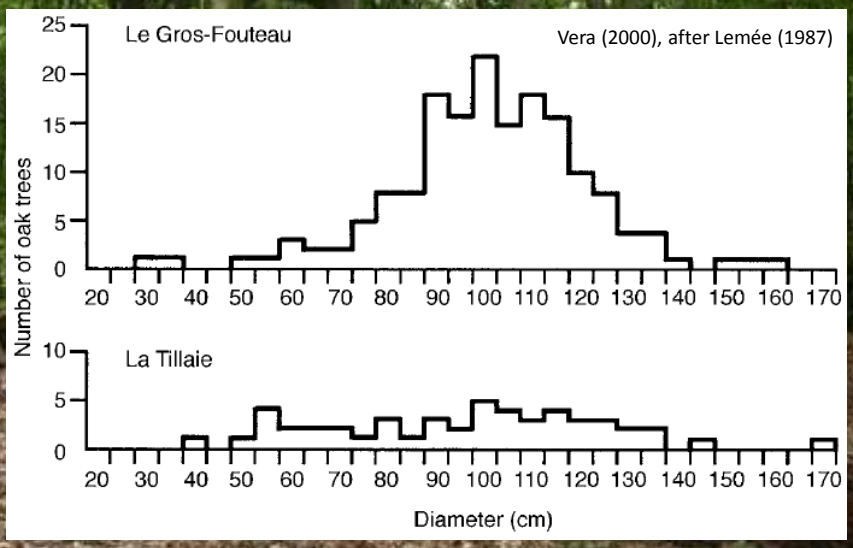
What makes oaks occurring in a phytocenosis?

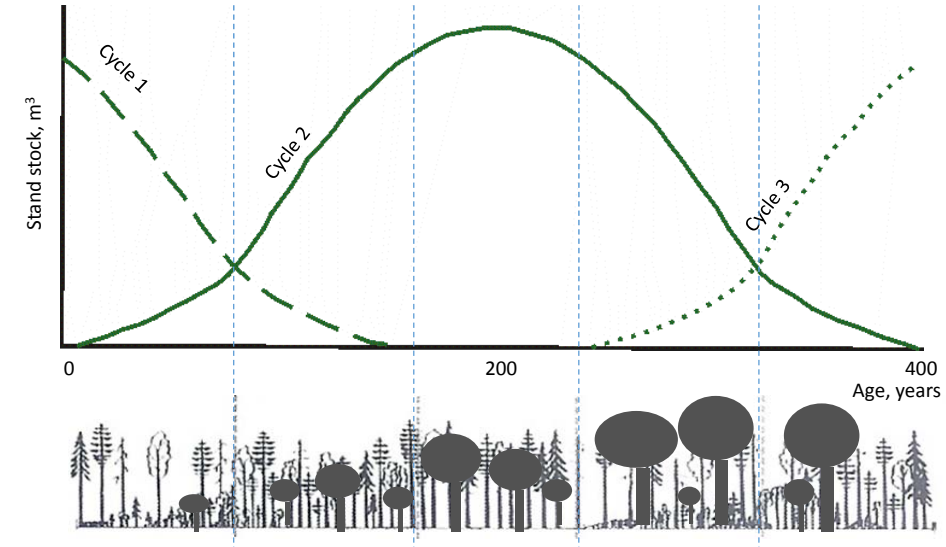


Frans Vera: oak does not regenerate (naturally) in contemporary forests – either managed or protected

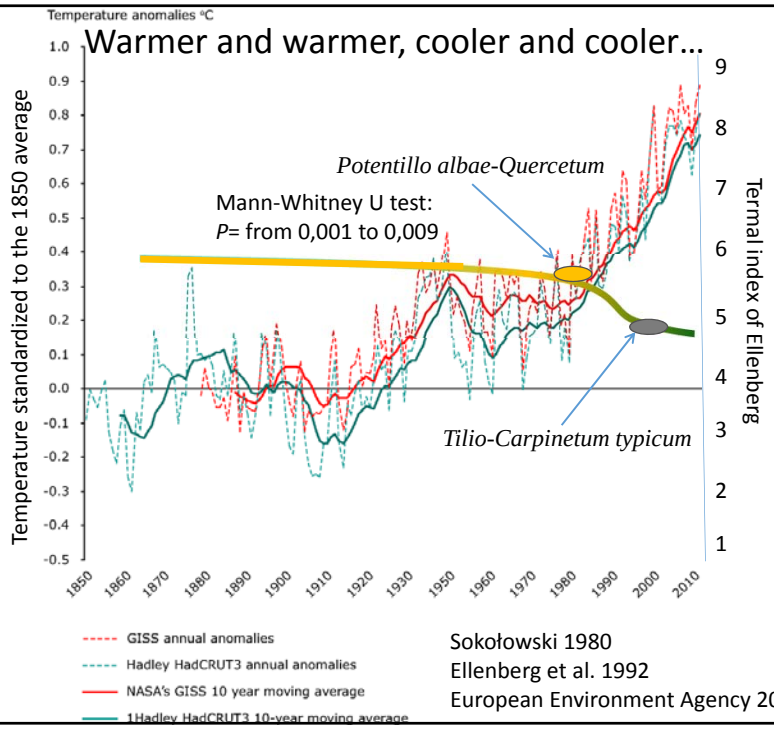


Oak stands structure in BNP and Fontainebleau



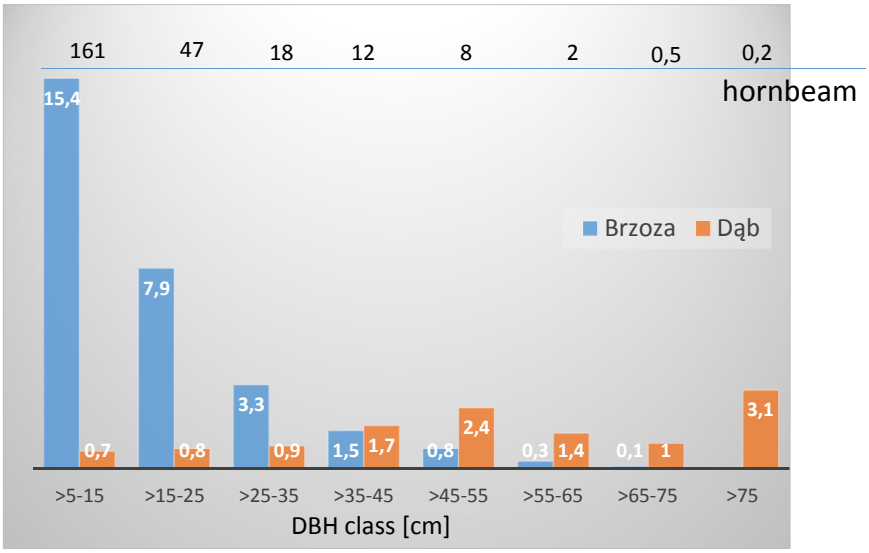

Cycle 1
Cycle 2
Cycle 3
Stand stock, m³
0
200
400
Age, years
cycle 1
cycle 2
cycle 3
Ageing phase
Regeneration phase
Decadence phase
Initial phase
Optimal phase
Ageing phase
Regeneration phase
Decadence phase
Initial phase

Warmer and warmer, cooler and cooler…



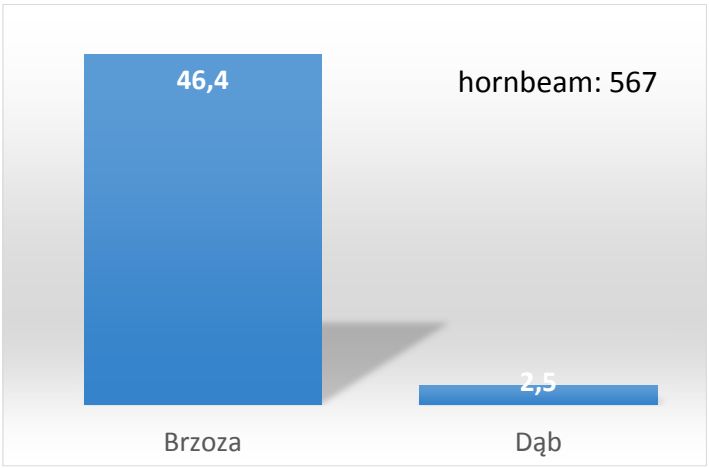
Sokołowski 1980
Ellenberg et al. 1992
European Environment Agency 2011

Average numer of trees per one hectare in BNP preserve



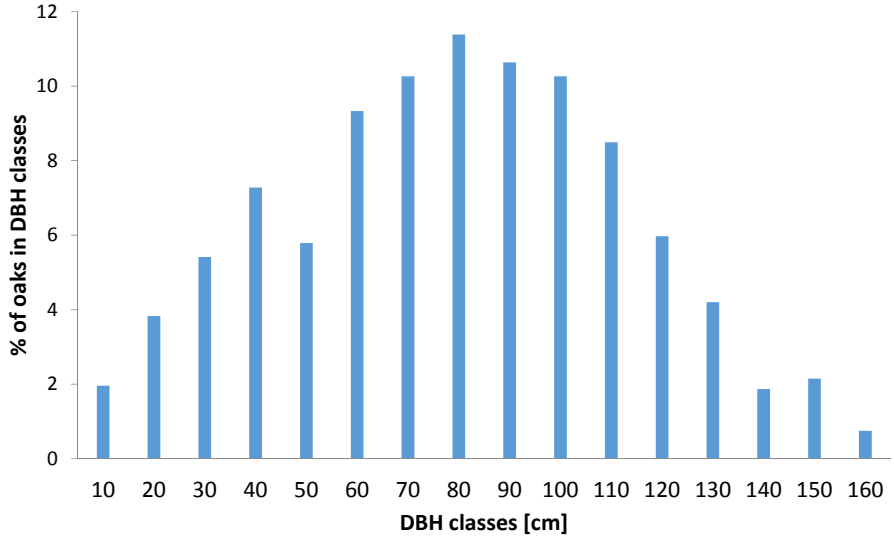
after Brzeziecki et al. (2010)

Average numer of saplings (height >1,3 m, diameter ≤ 5 cm) per one hectare of BNP preserve



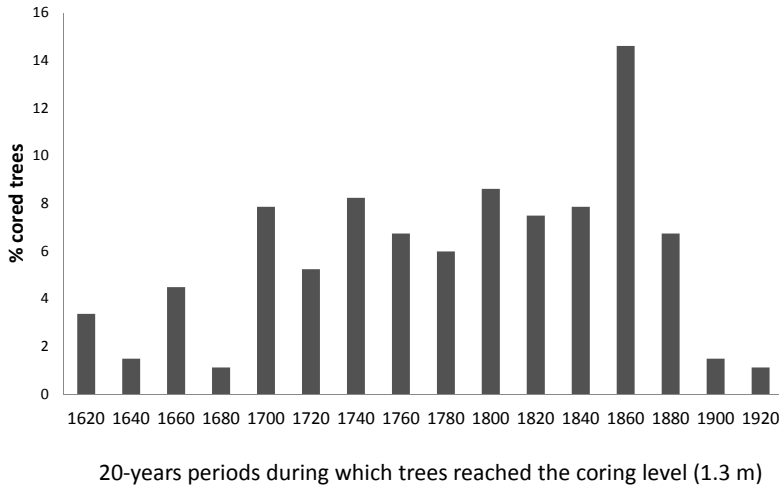
after Brzeziecki et al. (2010)

The oaks DBH structure in the BNP preserve



Oak regeneration dynamics during the last 300 years

in the area of the BNP preserve on eutrophic and mezotrophic sites



Michael Codd (1998) Wealden Iron Industry: Iron Ore Extraction, Minepits, Charcoal Burning, Coppicing, …

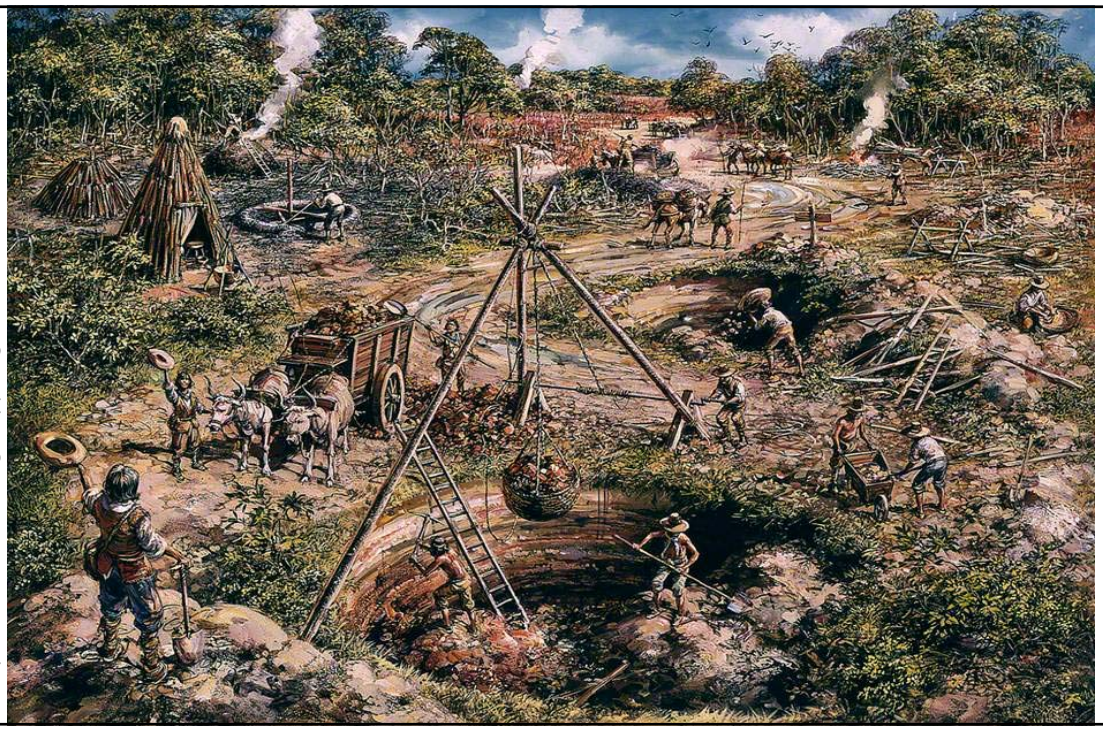
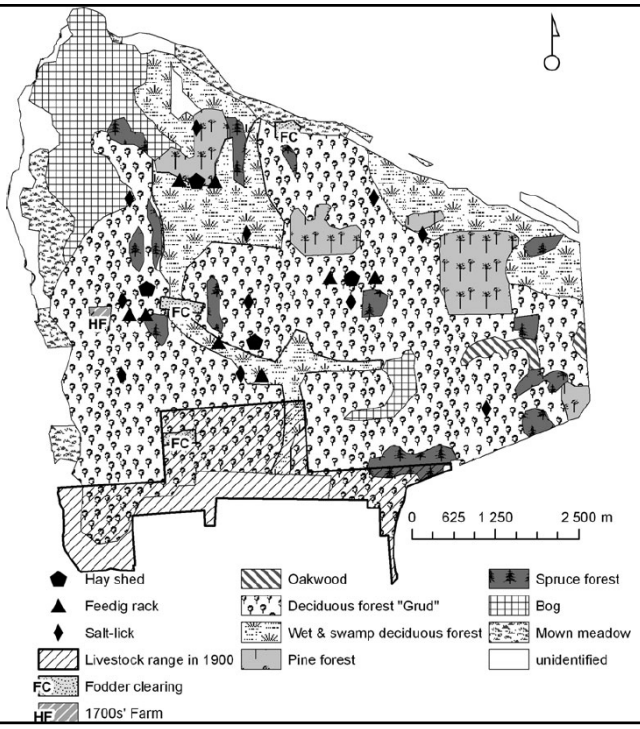


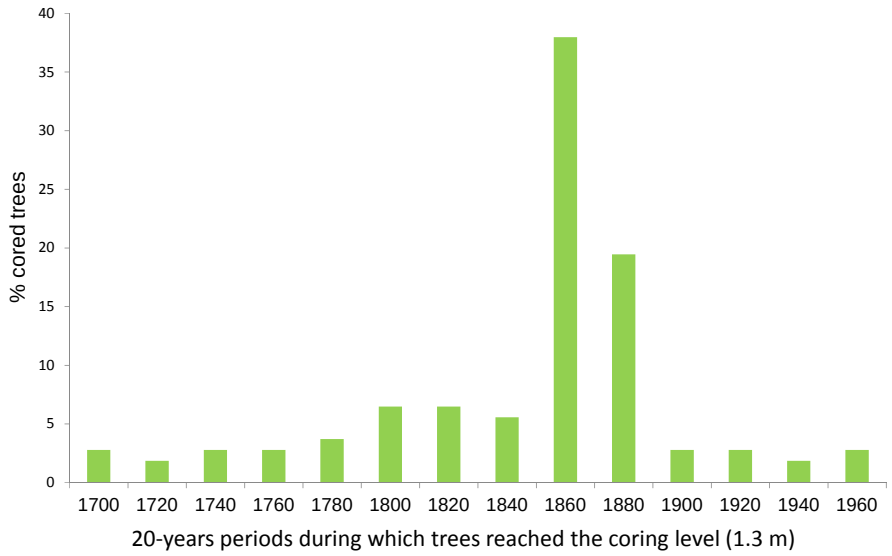
Fig. 2 The area of today's BNP preserve with forest types and the area accessed by livestock at the end of 1800s, adapted from the historic maps from Karcev (1903); three historic fodder clearings (of the 1800s) and the position of the 1700s' small settlement with farm located on the basis of the BNP digital map of stands and Borowik-Dabrowska and Dabrowski (1973)

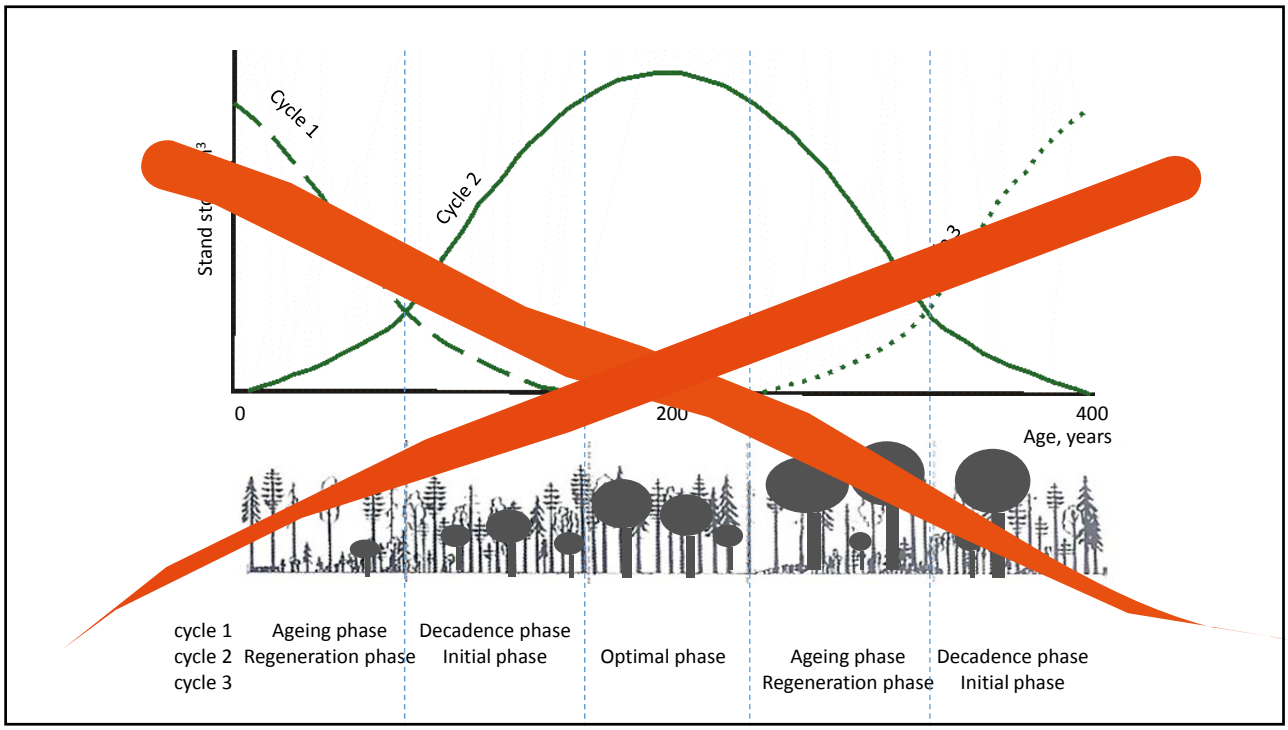


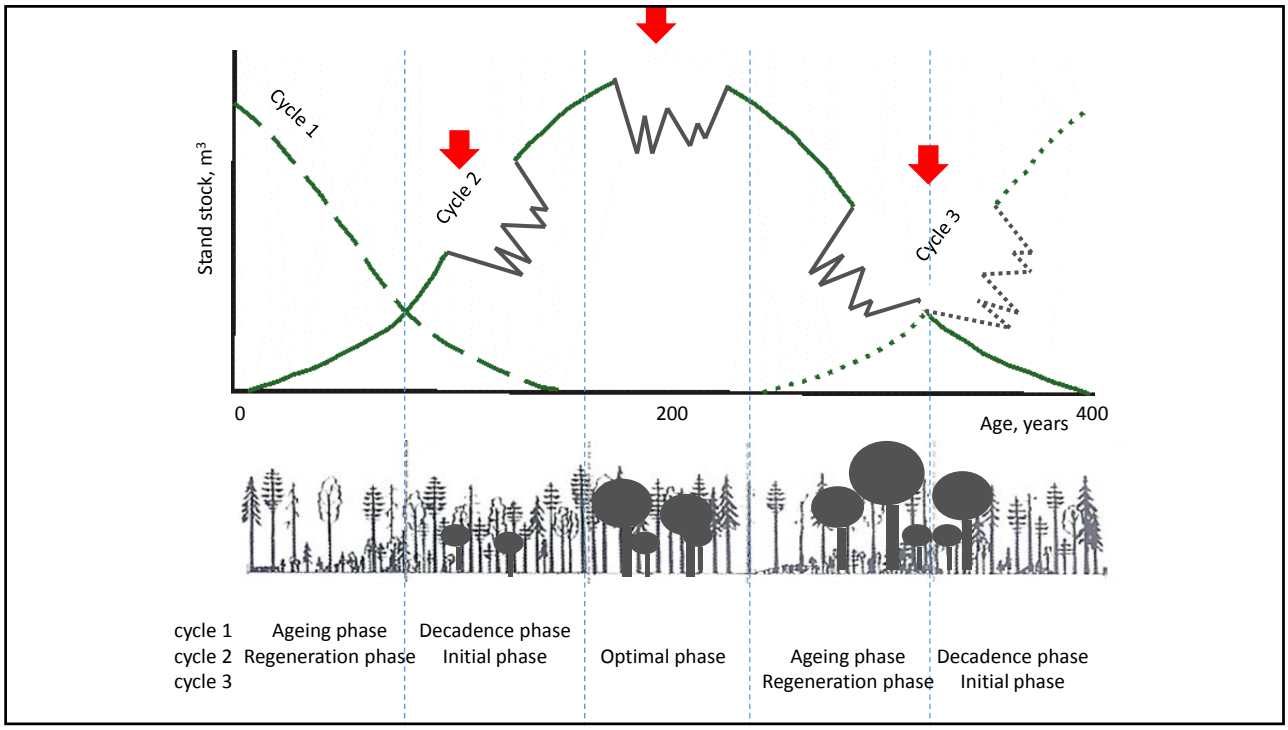
Bobiec (2012) Eur J Forest Res
DOI 10.1007/s10342-012-0597-6

Oak regeneration dynamics during the last 300 years

in the area of the BNP preserve on oligotrophic sites sites

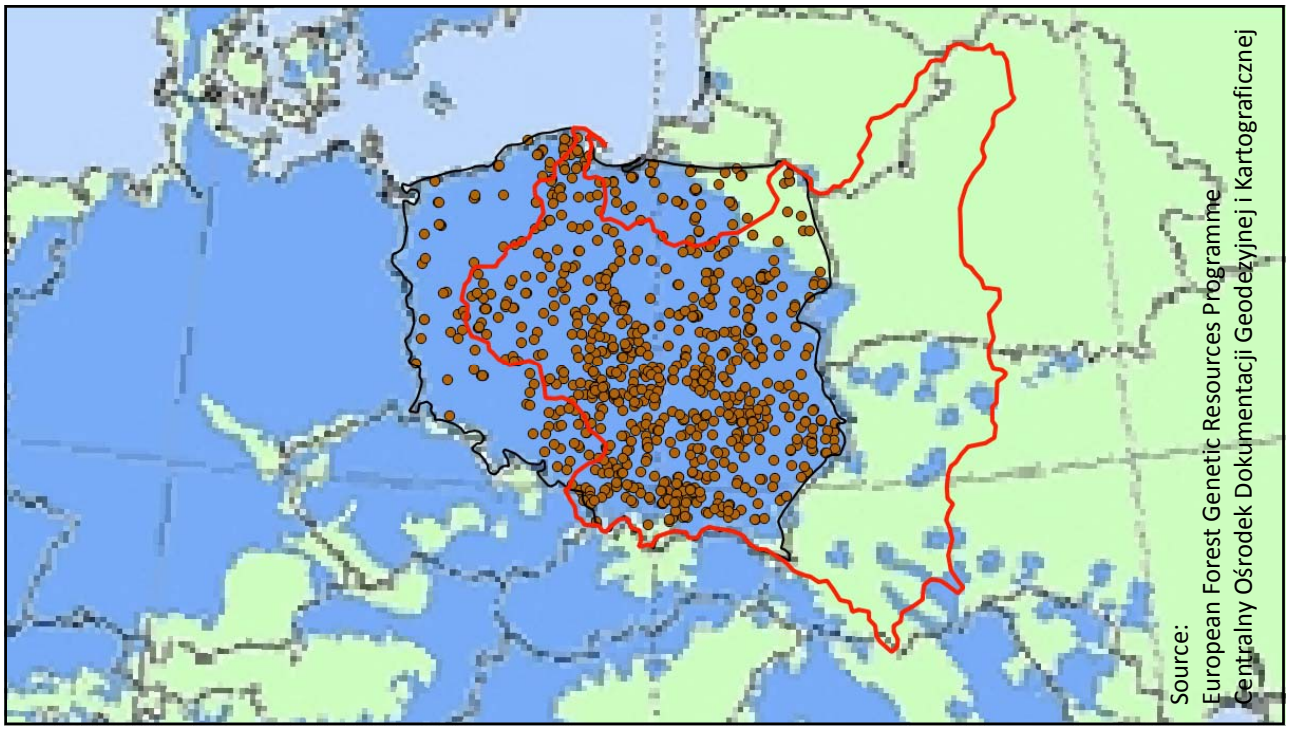


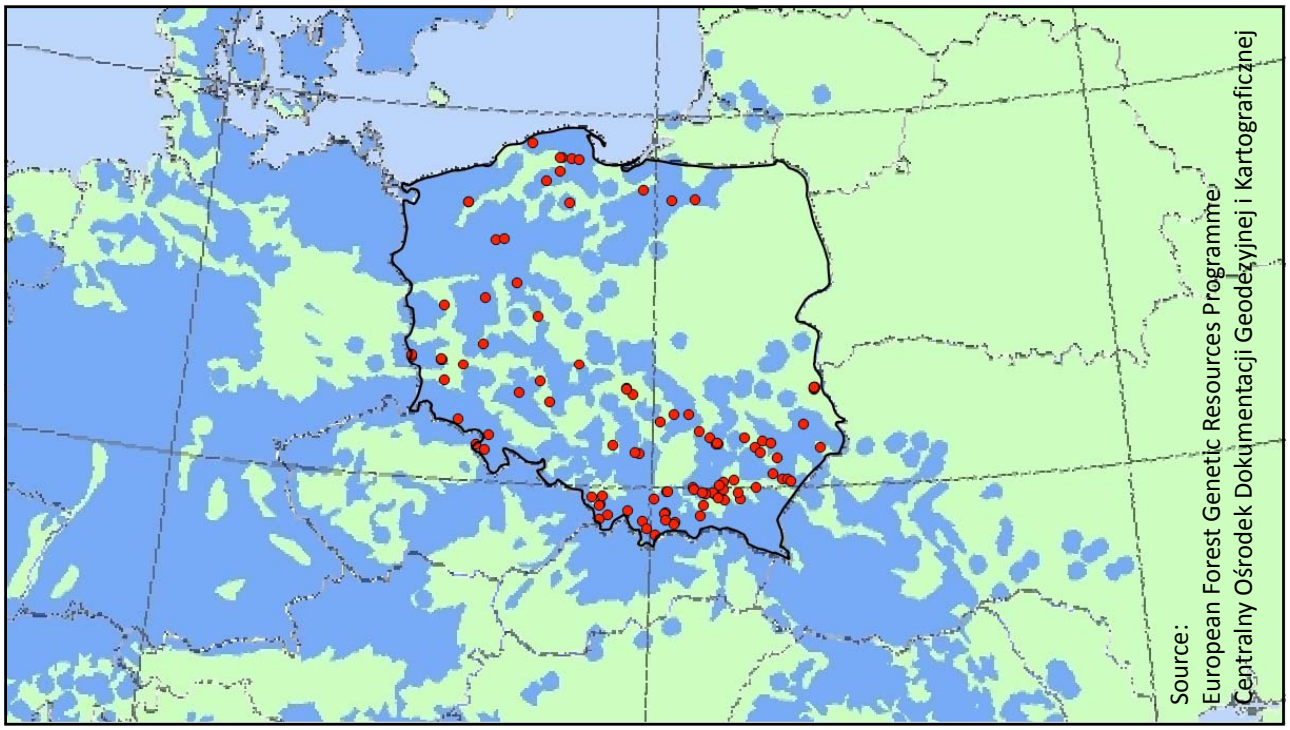

Cycle 1
Cycle 2
Cycle 3
0
200
400
Age, years
cycle 1
cycle 2
cycle 3
Ageing phase
Regeneration phase
Decadence phase
Initial phase
Optimal phase
Ageing phase
Regeneration phase
Decadence phase
Initial phase


Stand stock, m³
Cycle 1
Cycle 2
Cycle 3
0
200
400
Age, years
cycle 1
cycle 2
cycle 3
Ageing phase
Regeneration phase
Decadence phase
Initial phase
Optimal phase
Ageing phase
Regeneration phase
Decadence phase
Initial phase

Oakscape

Oakscape - a landscape fostering oak regeneration, recruitment and long-term presence. It consists of habitats that, within the oaks' dispersal range, fit their diverse ecological adaptations. They represent the species' regeneration niche (*sensu* Grubb 1977).





Oaks regeneration adaptations: (1) seeds dispersal

SPECIFIC DISADVANTAGES/ NEGATIVE FACTORS	COMPENSATION/ DEFENSE MECHANISMS	REGENERATION STRATEGIES
Competition from fast-growing tree species, with annual abundant seed rain	Long-distance zoochory	Escape to sites unaffected by pioneers' invasion (e.g. covered with dense graminoid sod)
Competition from stress-tolerant species, with abundant 'stand-by' seedling and sapling bank (shade-tolerant species)	Long-distance zoochory	Escape to sites free from shade-tolerant species: Dry sites with long vegetation period; alluvial sites; graminoid sod preventing undergrowth development; fire succession
Predation	Long-distance zoochory	Escape to sites with lower population sizes of acorn-dependent forest rodents
	Predator satiation	More efficient dispersal and caching by satiated forest rodents

Oaks regeneration adaptations: (2) germination and seedlings development

SPECIFIC DISADVANTAGES/ NEGATIVE FACTORS	COMPENSATION/ DEFENSE MECHANISMS	REGENERATION STRATEGIES
Infections / infestations / putrefaction	Long-distance zoochory	Avoiding high-risk areas (particularly in the shade of oak canopy, with hypothetically highest content of oak-specific pathogenic agents)
Desiccation	Long-distance zoochory. Deep rooting system. Ability to regulate transpiration by stomata closure	Caches under shallow ground, grass sod or moss cover securing optimal moisture conditions
Competition of herb layer vegetation (for light, macro-elements)	Initial independence from external energy and nutrient resources	Starch-rich acorns allow germinants develop into one-year-old saplings almost without light and mineral resources

Oaks regeneration adaptations: (3) sapling growth – tree recruitment

SPECIFIC DISADVANTAGES/ NEGATIVE FACTORS	COMPENSATION/ DEFENSE MECHANISMS	REGENERATION STRATEGIES
Stress: Lack of light (photosynthetically active radiation, PAR)	Long-distance zoochory	Escape to more open or richer in moisture sites (moisture to some extent compensates shade-intolerance)
Grazing	Biomass allocation to root system, healing, regrowth, resprouting potential	With higher PAR level (open/ semi-open sites) faster photosynthesis, more efficient compensation of injuries, higher survival rate; Higher level of acceptable damages; ability to resprout
Browsing	Associational resistance. Numeric dilution	Lower probability lethal damages from grazing/ browsing; ability to resprout

Oakscape habitats review

Johann Bernard Klombeck (1815-1893) A winter landscape

Oakscape habitats

High deciduous forest: not an obvious oak habitat

- Poor light condtions
- Competiton from shade-tolerant trees establishing undergrowth and advance regeneration (seedlings/ saplings bank)

Oakscape habitats

Extra-zonal habitats:

(1) acidophilous oak woods (9190)
(2) Pannonian-Balkanic turkey oak – sessile oak forests (91M0)
(3) Euro-Siberian steppic woods with Quercus spp.

- No or poor competition from more demanding decidous species

Oakscape habitats

Understocked stands with discontinued canopy;

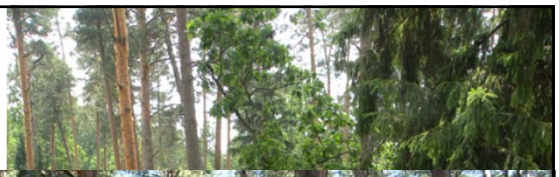
depending on the intensity of pressures and impacts they may range from 'shadow woods' to 'fringe-and-mantle' or savanna-like habitat. Due to highly adapted life strategy, oaks are often dominating tree species.

- Competition reduced by anthropogenic disturbances (e.g. repetitive ground fire).

SW Ukrainian Prykarpattya: wide ecotone zone created by frequent spring grass burning

Oakscape habitats

Pine stands (including plantations)



- Acceptable light supply;
- Reduced competition from deciduous species;
- Relatively long disturbance-free period

Oakscape habitats

Wood-pastures - Silvo-pastoral landscapes with park-like oak groves (shadow-woods)

- Competition reduced by grazing

Oakscape habitats

Abandoned pastures, meadows and ploughfields;
Abandoned fruit orchards.

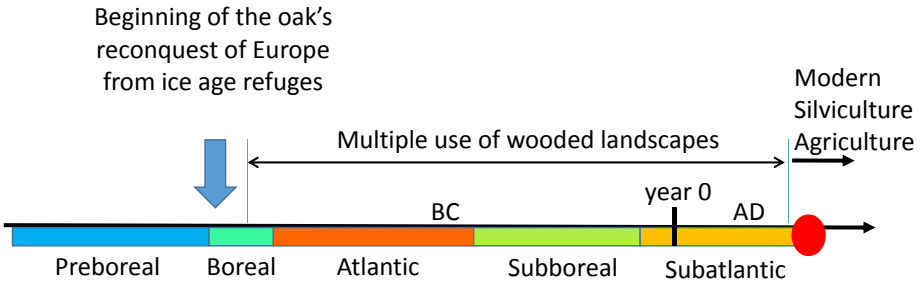
- Reduced competition + optimal light supply

Oakscape habitats

(sub-)Urban wastelands;
Roadsides and railways;
Power line zones.

- Reduced competition + optimal light supply

Modern agriculture and forestry: two silent revolutions



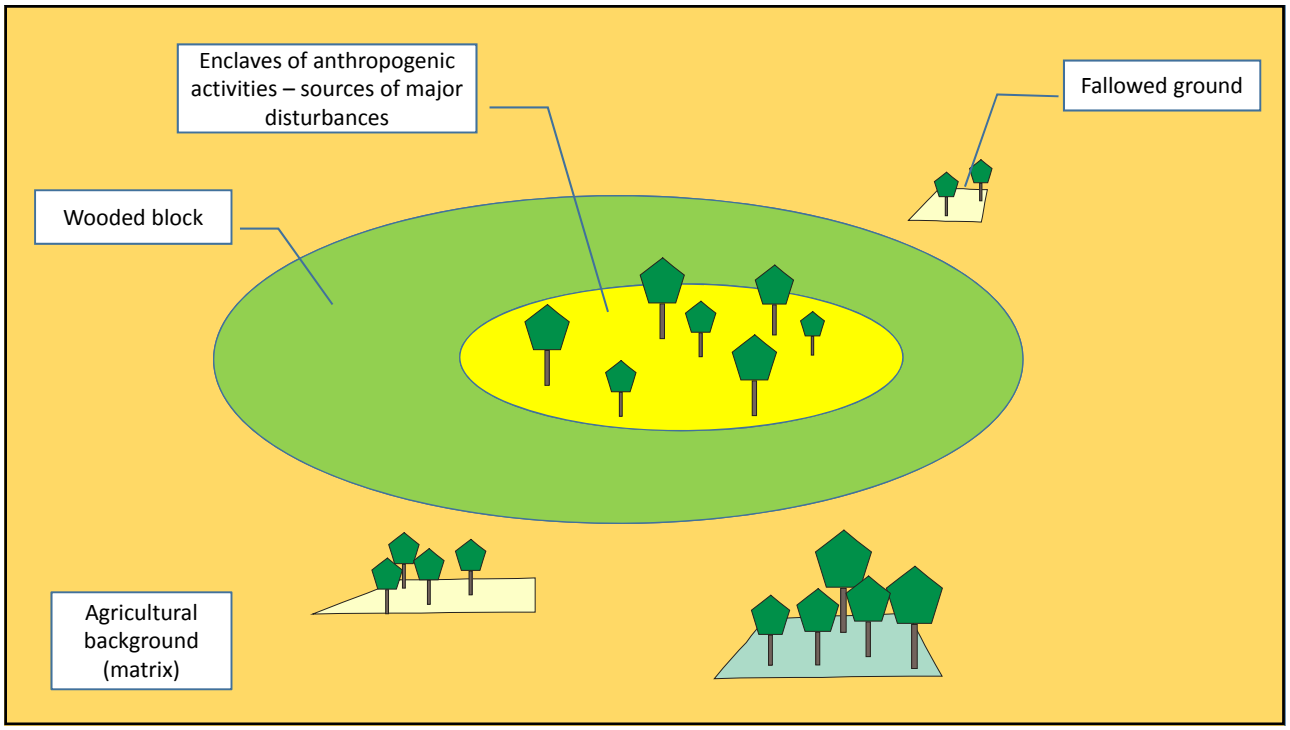


Photo: K. Skrobacz

Literature meta-analysis

- 229 pieces of literature from Web of Science data base, published between 1968 and 2016, dealing with Q. robur or Q. petraea regeneration were subject to systematic scrutiny.
- Only 29 papers (13%) considered acorns dispersal. 38% of these studies were carried out on the scale of landscape mosaics – significantly more (Chi-square test, $P<0.001$), than 11% of studies ignoring dispersal stage. This implies that the vast majority of oak regeneration studies refer to specific circumstances of selected habitats but not to the actual range of the trees reproductive effort.
- 74% of analyzed studies were performed in high forest habitats – prefered by foresters but not suitable for spontaneous oak regeneration.

Conclusions

- The habitually accepted assumption that Q. robur and Q. petraea are 'forest-making' trees is based on the performance of adult trees, rather than on their whole life history (‘forest perspective bias’).
- Contemporary mature or old-growth oak stands, unless planted, are either legacies of abandoned ancient silvopastoral woods 'swallowed' by developing forest communities, or, as in Białowieża, they emerged in result of untypical, usually of anthropogenic origin, disturbances.
- Therefore, one should not draw general conclusions on the oak regeneration potential from studies performed in a sole type of habitat. For instance, observation of the best-preserved deciduous and mixed forests alone, unless heavily modified by disturbances, must lead to the worrying conclusion of oak regeneration failure.

Conclusions

- The deficit of younger spontaneously regenerated oak stands in contemporary European landscapes is caused by changes in landscape management, not by intrinsic species regeneration problems. Once colonized by a single cohort (usually after a mast year), a patch of habitat should be left without major disturbance for 2-5 decades allowing further cohorts to join and oak saplings to recruit as trees.
- Modern European forestry following the utmost care to perpetuate high timber stock and permanent forest cover precludes spontaneous processes conditioning gradual development of new generations of oak stands. Exceptions are light pine stands and certain floodplain forests.
- Ironically, such situations are often prevented in the European Union by the current agricultural practices, such as cleaning pastures and mandatory mowing of grasslands imposed by agri-environment schemes in high-nature-value rural landscapes through the Rural Development Policy (European Union, 2013).

Conclusions

- In high-nature value traditional rural landscapes, free-range pasturing could be the most efficient policy aiming to increase and perpetuate the presence of oak. In addition, wastelands, fallows and ruderal barrens in rural or urban settings, thanks to the well-documented ecosystem service provided by Jays, often foster the development of valuable woodlots with a high share of oaks.
- Strict artificial borders separating agricultural and forest land should be superseded by wide ecotonal zones, where agricultural activities (pasturing in particular) will be allowed to shape wooded areas, transformed into savannah-like communities, fostering oaks gradual recruitment. Such should be the role of 'buffer zones' around forested protected areas.

Charles-Emile Jacque
A Shepherd watering the flock

Иван Шишкин (1832-1898) На покосе в дубовой роще, 1874

Bibliograhpy

- Annighöfer, P. P., Beckschäfer, Vor, T. & Ammer, C. (2015) PLoS ONE, 10: e0134935.
- Bakker, E.S., Olff, H., Vandenberghe, C., De Maeyer, K., Smit, R., Gleichman, J.M. & Vera, F.W.M. (2004) J Appl Ecol, 41, 571–582.
- Bergmeier, E., Petermann, J. & Schröder, E. (2010) Biodiv Cons, 19, 2995–3014.
- Bobiec, A. (2012) Eur J For Res, 131, 1269–1285.
- Bobiec, A. (2007) Pol J Ecol, 55, 441-455
- Bobiec, A. & Bobiec, M. (2012) Sylwan 156 (4), 243-251
- Bobiec, A., Jaszcz, E., Wojtunik, K. (2011) Eur J Forest Res, 130, 785-797
- Bobiec, A., Kuiper, D.P.J, Niklasson, M., Romankiewicz, A. & Solecka, K. (2011) For Ecol Manage, 262, 780-790
- den Ouden, J., Jansen, P.A. & Smit, R. (2005) (eds P.M. Forget, J.E. Lambert, P.E. Hulme & S.B. Vander Wall), pp. 223–240. CABI publishing, Wallingford, UK.
- European Commission (2013) Interpretation Manual of European Union Habitats. http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf. DG Environment, Brussels, Belgium.
- Gómez, J.M. (2003) Ecography, 26, 573–584.
- Herlin, I.L.S. & Fry, G.L.A. (2000) Lands Ecol, 15, 229–242.
- Kollmann, J. & Schill, H-P. (1996) Vegetatio, 125, 193–205.
- Kuiters, A.T. & Slim, P.A. (2003) For Ecol Manage, 181, 239–251.
- Minotta, G. & Degioanni, D. (2011) iForest, 4, 31–37.
- Montoya, D., Alburquerque, F.S., Rueda, M. & Rodriguez, M.A. (2010) Oikos, 119, 1335–1343.
- Olrik, D.C., Hauser, T.P. & Kjaer, E.D. (2012) Scand J For Res, 27, 350–360.
- Palmer, S.C.F., Mitchell, R.J., Truscott, A.M. & Welch, D. (2004). For Ecol Manage, 192, 251–265.
- Rackham, O. (2006) Woodlands. Collins New Naturalist, Harper Collins, London, UK.
- Shaw, M.W. (1968a) J Ecol, 56, 565–583.
- Shaw, M.W. (1968b) J Ecol, 56, 647–660.
- Shaw, M.W. (1974) (eds., M.G. Morris & F.H. Perring), pp. 162–181. E.W. Classey Ltd., Faringdon, Berkshire, UK.
- von Lüpke, B. (1998) For Ecol Manage, 106, 19–26.
- Watt, A.S. (1919) J Ecol, 7, 173–203.
- Ziobro, J., Koziarz, M., Havrylyuk, S., Korol, M., Ortyl, B., Wolański, P., Bobiec, A. (2016) Prace Geogr, 146, 67–88, doi: 10.4467/20833113PG.16.018.5548