FOREST4EU

ITHub 3 - Sustainable Forest Management and Ecosystem Services

FOREST4EU partner: CNPF

OG: SPNA

OG's country: France

Type of Innovation: Technological

The ARCHI method: a tool for diagnosing the vitality of trees

Introduction

Vitality of trees is conditioned by genetics, as well as by two fluctuating factors: aging on the one hand and environmental constraints on the other. Diagnosing vitality is therefore a question of defining both the stage of development and the physiological state. We are able to calculate the age of a tree by counting the rings on a core of wood taken from the base of the trunk. The trouble is that this chronological age is not correlated with development. How long does the youth stage, adult stage and maturity last? Moreover, the classic measurements of diameter and height are of no help, the oldest subjects not being systematically the largest or the tallest. However, the architecture of a tree, that is to say the way in which it is built and repaired, constitutes a real biological signature of its vitality, this is the principle of the ARCHI method.

ARCHI methodology and typology

Vitality of trees is conditioned by genetics, as well as by two fluctuating factors: aging on the one hand and environmental constraints on the other. Diagnosing vitality is therefore a question of defining both the stage of development and the physiological state. We are able to calculate the age of a tree by counting the rings on a core of wood taken from the base of the trunk. The trouble is that this chronological age is not correlated with development. How long does the youth stage, adult stage and maturity last? Moreover, the classic measurements of diameter and height are of no help, the oldest subjects not being systematically the largest or the tallest. However, the architecture of a tree, that is to say the way in which it is built and repaired, constitutes a real biological signature of its vitality, this is the principle of the ARCHI method.

The vitality of a tree must constantly be evaluated. After planting, to judge the quality of the resumption of growth; during development, to adapt the type of pruning, its frequency and its intensity; following an environmental constraint, to anticipate the reversible or irreversible nature of a decline; at the time of a mechanical diagnosis, to estimate the physical resilience capacity of a subject deemed to be fragile; also at the end of life, to recognize the natural or premature nature of mortality.

Six physiological states are assigned to the young, adult and mature stages of development.

The senescence inevitably leads to a natural death.

- Healthy: a tree without any significant symptom of crown degradation and whose architecture is in accordance with its development stage.
- Stressed: a tree that undergoes stress, which can be seen by changes in its architecture (impoverishment of ramification, mortality, possibly the appearance of epicormic shoots, etc.), without it being possible for the observer to instantly decide on its future restoration or further degradation, based on the assessment.
- Resilient: a tree whose crown development resumes normal architectural dynamics, after a deviation from the normal. This is mainly thanks to the development of orthotropic epicormic shoots in the upper canopy.
- Crown retrenchment: a tree in the dynamic formation process of a new, secondary crown below the original canopy, which eventually dies.
- Fallback: a tree that does not have a living upper canopy but continues to function with unaltered lower branches from its original structure. The tree does not form a secondary crown, so it is not in a crown retrenchment process.
- Irreversible decline: a tree with a degraded crown (impoverished ramification, abnormal mortality) without any viable restoration process (epicormic shoots are almost absent or, on the contrary, abundant but (almost) all of the ageotropic type).

Lessons learned

The ARCHI method is aimed at foresters, ecologists, arborists, teachers and researchers. There is a good correlation between the six physiological states and the width of the wood rings or the NDVI index (Normalized Difference Vegetation Index) measuring the photosynthetic activity of the foliage. For several tree species, a dichotomous ARCHI key has been developed in order to support, facilitate and objectify the architectural analysis of individual trees. These keys are tree species specific. Currently (2023) ARCHI keys are available for the 18 following species: Quercus (robur, petraea, pubescens, ilex, suber), Fagus sylvatica, Platanus x acerifolia, Castanea sativa, Cedrus atalantica, Pinus pinaster, Pinus sylvestris, Pinus nigra (ssp. nigra, ssp laricio var. corsicana, ssp. salzmannii), Abies alba, Pseudotsuga menziesii, Picea abies.

The ARCHI keys can be downloaded from: https://www.cnpf.fr/archi/.

An app based on the principle of ARCHI keys, which can be used on tablets and phones, is under development.

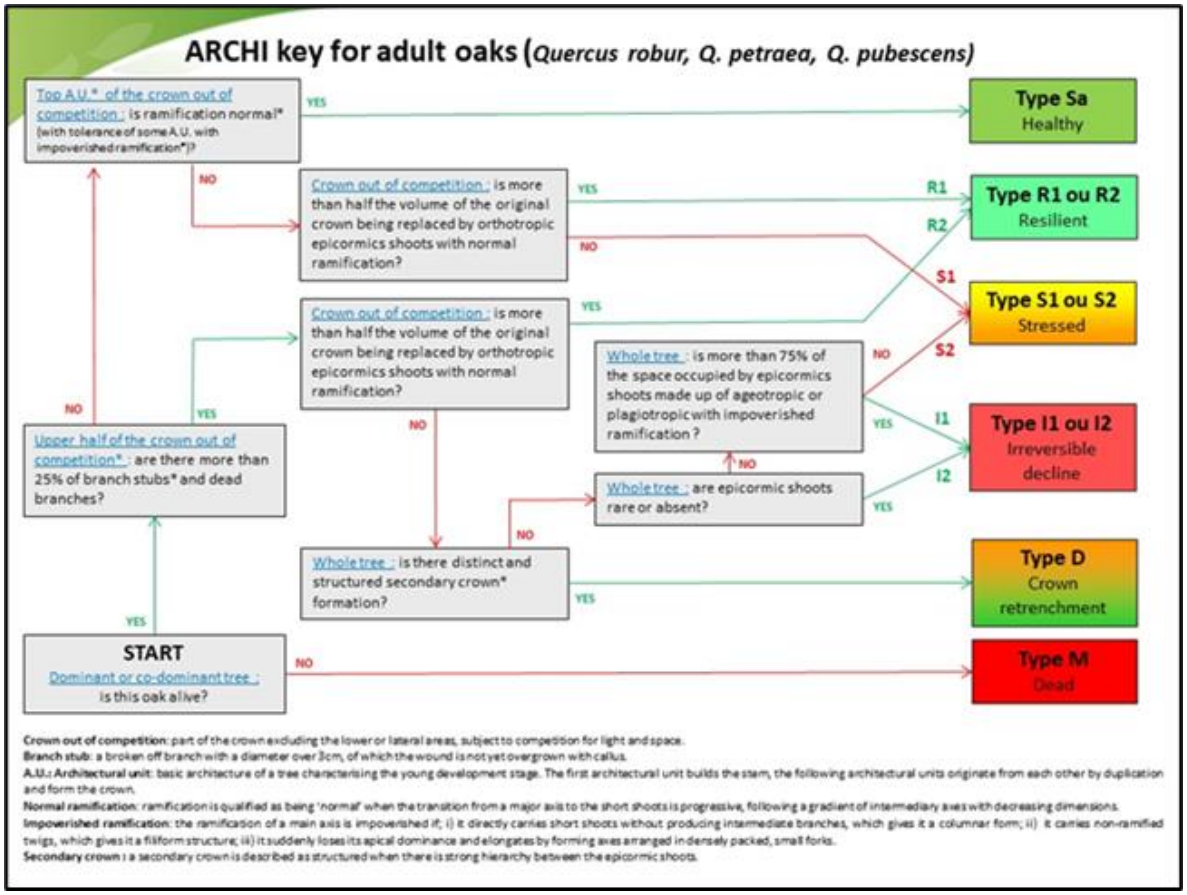

Figure 1. Presentation of the ARCHI key for adult oaks (Quercus robur, Q. petraea, Q. pubescens).

©CNPF

The information presented in this factsheet was developed by the FOREST4EU partner, drawing on the innovations and knowledge generated by the indicated operational group with their explicit authorization.

Further information

https://www.cnpf.fr/nos-actions-nos-outils/outils-et-techniques/archi

Funded by the European Union

Funded by the European Union (Grant n. 101086216). Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or REA. Neither the European Union nor the granting authority can be held responsible for them.