



Morphophysiology Stage 8

The gateway to
veteran or death

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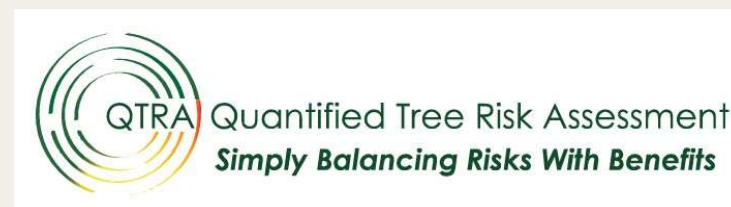
How do we Know What is True?

Observation v Hypothesis tested by Experiment

Observation is susceptible to confirmation bias – you see what you are looking for but ignore contradictory evidence

If a hypothesis cannot be proved wrong, it remains sound until new evidence contradicts it

James Chambers TMA Environmental Consultants



Dip Arb L6 (ABC)



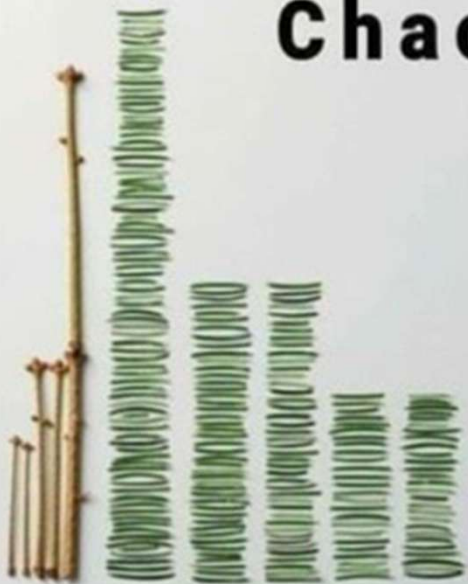
A photograph of a large, mature tree with a thick, textured trunk and a dense canopy of green leaves. The tree is the central focus, with its branches spreading out against a dark, overcast sky. The text "Tree Architecture" is overlaid in a large, white, sans-serif font across the middle of the image. The background shows other trees and foliage, creating a sense of a forest or park setting.

Tree Architecture

Order



Chaos



“The architecture of a tree is the expression of an equilibrium between endogenous growth processes and external constraints imposed by the environment.”

(Edelin, 1984)



ANCIENT
TREE
FORUM



“The architecture of a plant refers to the nature and the mutual arrangement of each of its parts”

(Edelin, 1984)

Jeanne Millet

Preface by Roelof A.A. Oldeman and Frédéric Back

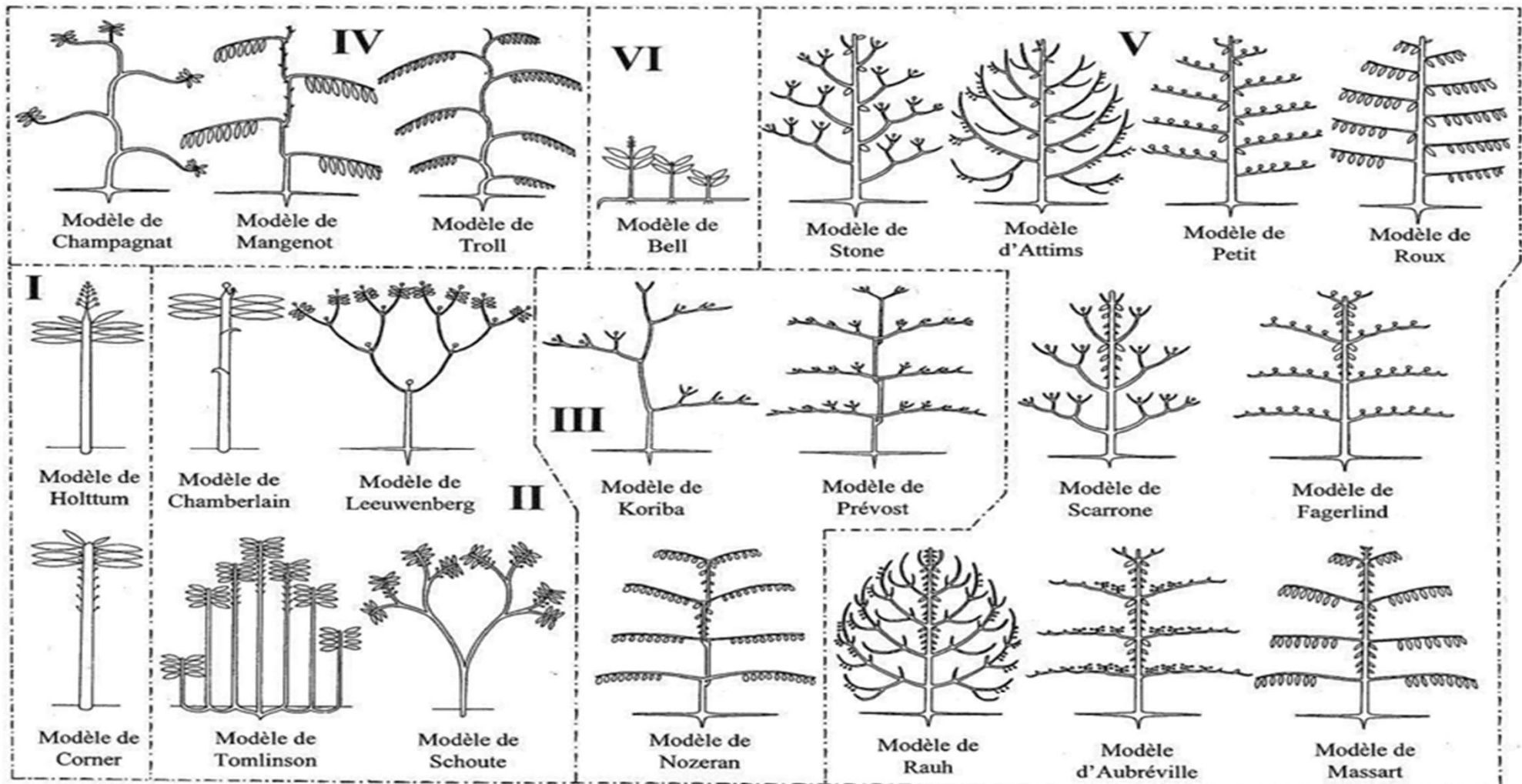
The architecture of trees in temperate regions

ITS HISTORY, CONCEPTS, AND USES

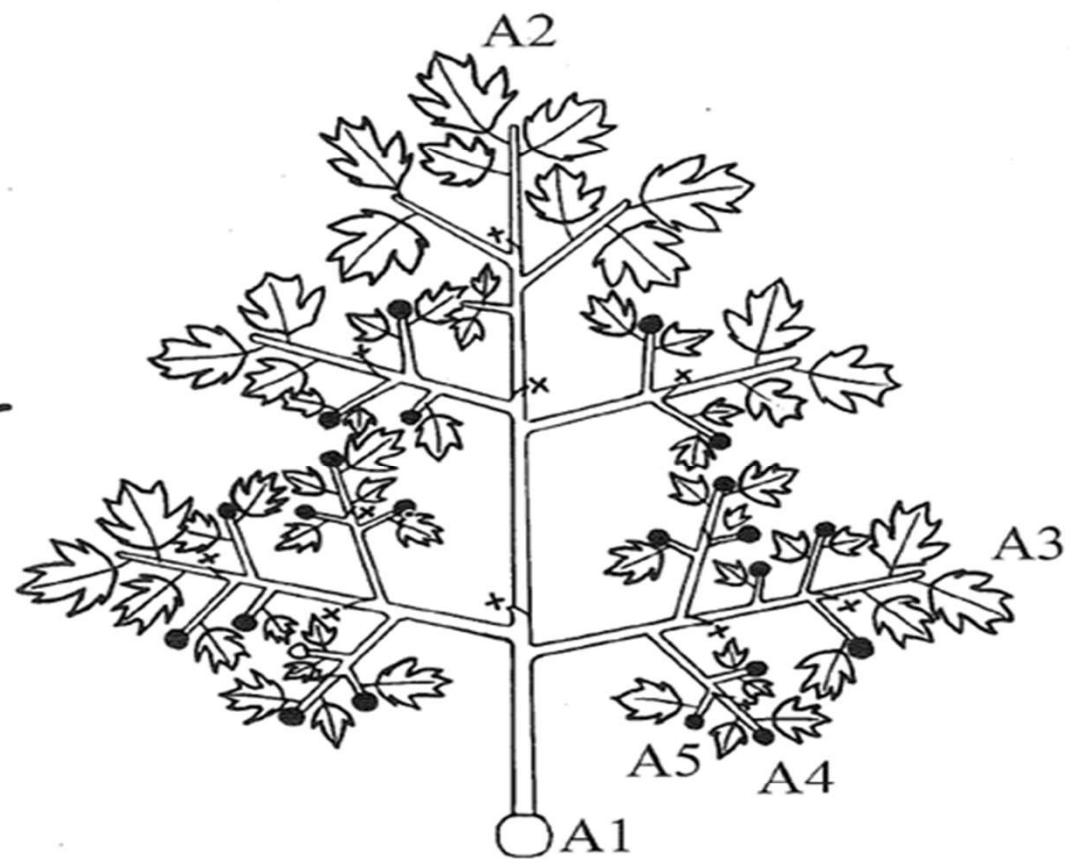
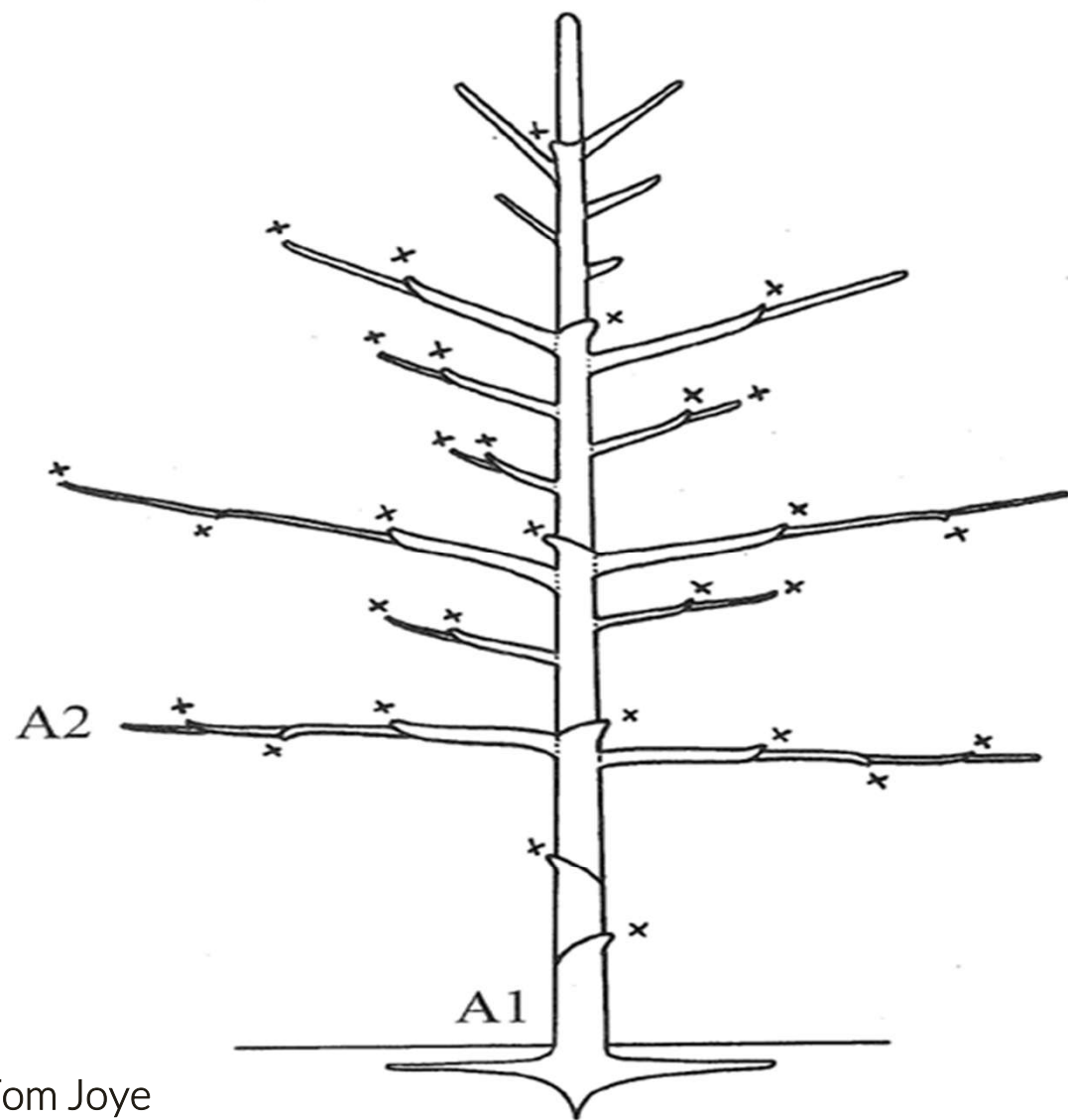


Translated from the third French edition by Jeanne Millet and Sylvie Guérette





► 22 architectural models (now: 24)



Tom Joye

Form and position of epicormic growth

Orthotropic

- ▶ Repetition of a young tree (total reiteration, incl. A1)

Plagiotropic

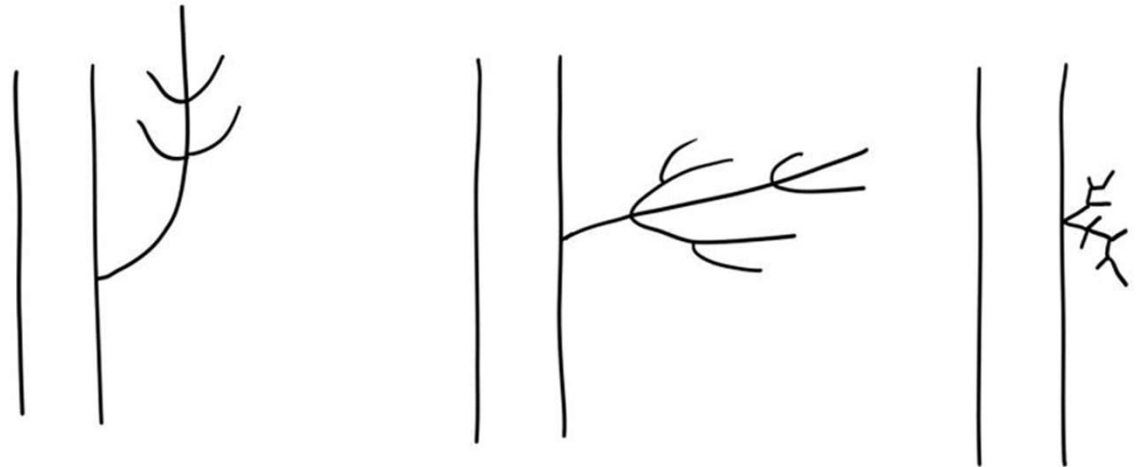
- ▶ Repetition of a branch (partial reiteration, without A1)

Ageotropic

- ▶ Resembles the minimal units of a senescent tree

inverde

Types of epicormic



inverde

Growth direction and symmetry

Orthotropic

- ▶ Axis grows more or less upright, radial symmetry

Plagiotropic

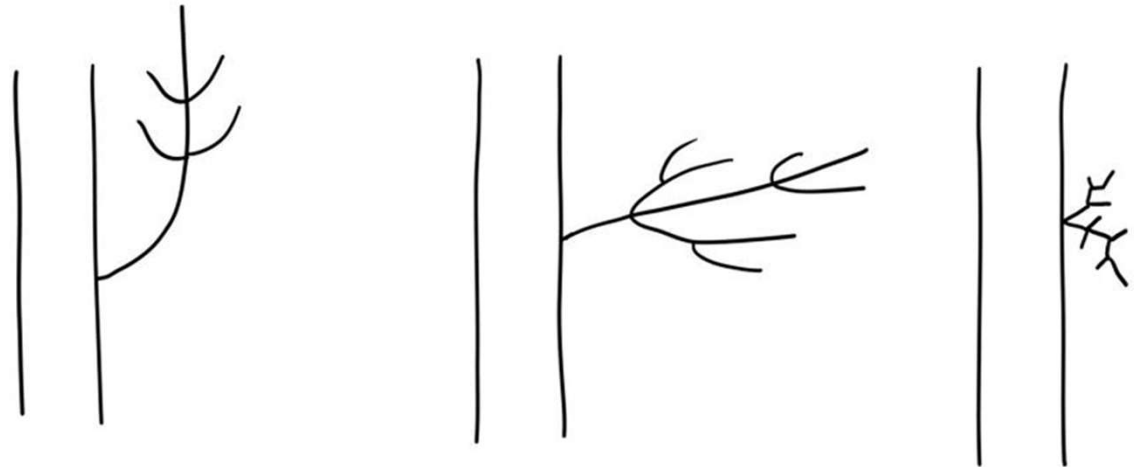
- ▶ Axis grows more or less horizontal, bilateral symmetry

Ageotropic

- ▶ Axis has no preferential growth direction, no branching

inverde 

Types of epicormic



inverde 

Monopodial or sympodial growth?

Monopodial:

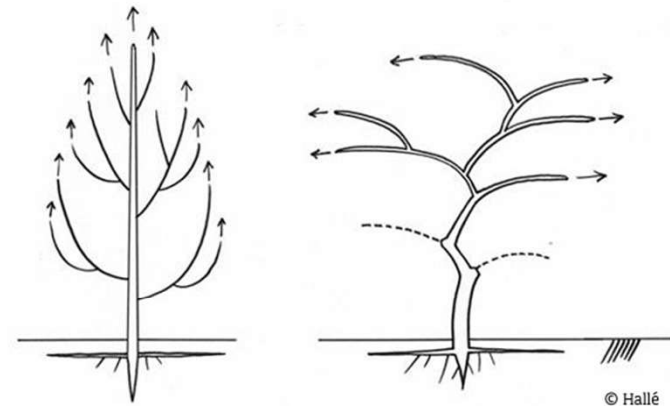
- ▶ Terminal meristem (bud) retains apical dominance

Sympodial:

- ▶ Apical dominance is transferred from one meristem to another
- ▶ Terminal meristem aborts or is transformed (flower, vine, ...)

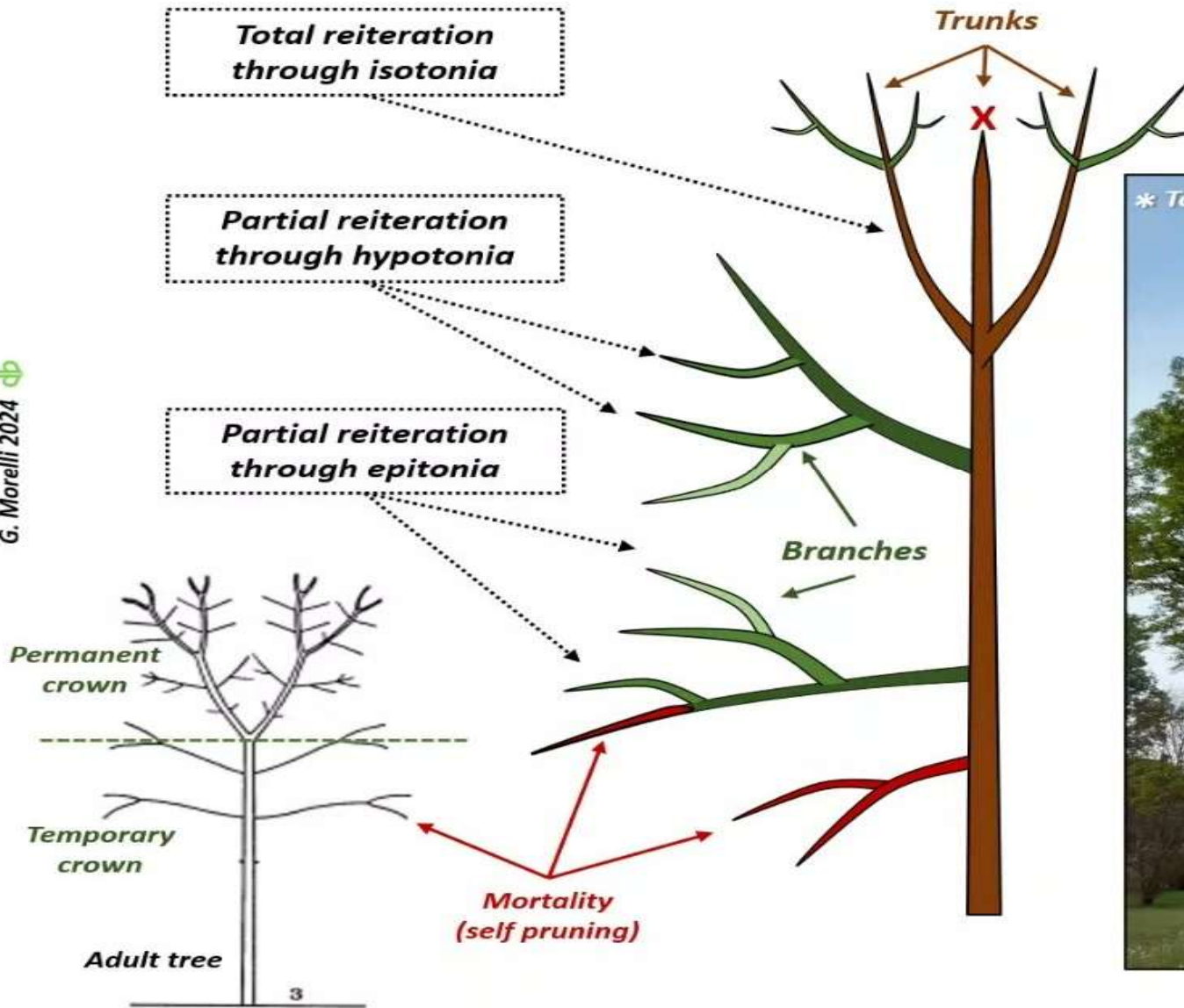
inverde 

Growth direction and symmetry



inverde 

Trunks, branches, total reiteration and mortality



Platanus x hispanica

A1	A2	A3	A4	A5
linear sympode	linear sympode	linear sympode	linear sympode	linear sympode
rythmic growth	rythmic growth	rythmic growth	rythmic growth	rythmic growth
	annual module of +/- 15 nodes	annual module of +/- 10 nodes	annual module of 7 nodes	annual module of 5 nodes
Ramification rythmic, delayed, acrotonic	Ramification rythmic, delayed, acrotonic	Ramification rythmic, delayed, acrotonic	Ramification rythmic, delayed, acrotonic	Short shoot, no ramification
orthotropic	plagiotropic	plagiotropic	plagiotropic	plagiotropic
radial symmetry	bilateral symmetry	bilateral symmetry	bilateral symmetry	bilateral symmetry
infinite lifespan	finite lifespan (long term)	finite lifespan (medium term)	dies after 1 – 6 years	dies after 1 – 4 years
no flowering	no flowering	no flowering	terminal flowering	terminal flowering

A large, ancient tree with a thick trunk and dense green foliage, set in a grassy field. The tree's trunk is gnarled and weathered, with a prominent, twisted branch extending upwards. The canopy is lush and green, filling much of the upper frame. The background shows a grassy field and other trees in the distance under a clear sky.

Morphophysiology



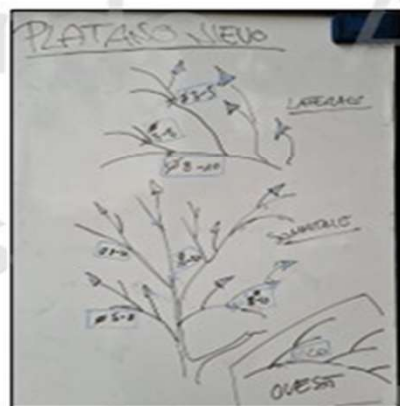
Giovanni Morelli and **Stefania Gasperini**, Italy

Why “Retrenchment Pruning” Doesn’t Work



Stage 8 Oak
Brampton Bryan, Herefordshire

Objectives: get a reaction



Crown evolution in polyarchic species

Stage 1-4:
building the
trunk



Stage 5-6:
building the
crown



*Acropetal
mortality*

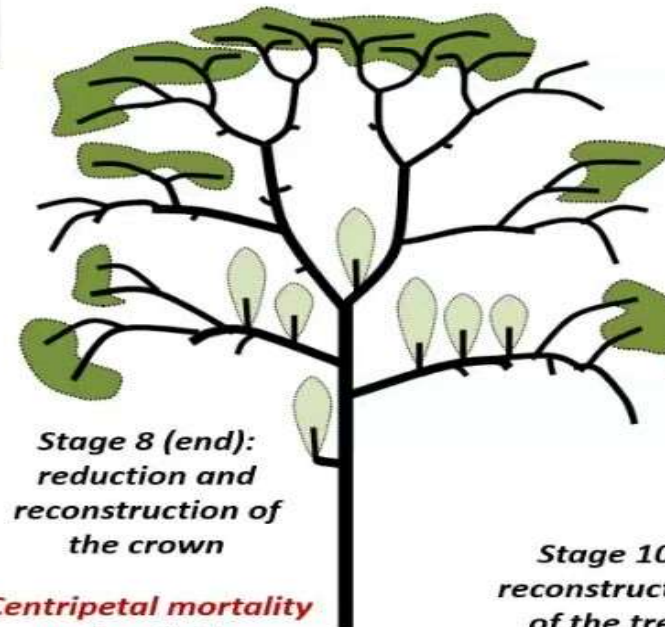
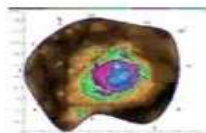
Stage 7:
renewal of the
crown



*Centrifugal
mortality and
heartwood
formation*

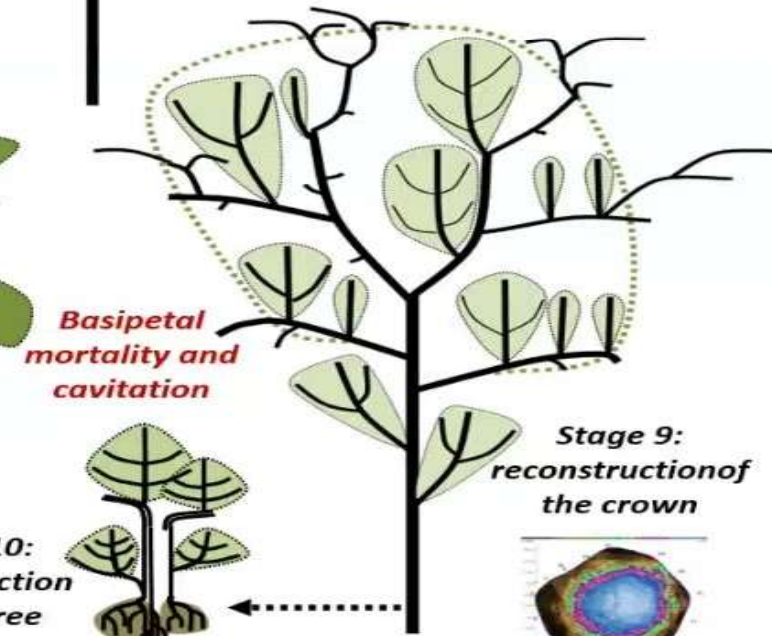


Stage 8
(beginning):
renewal and
reduction of
the crown



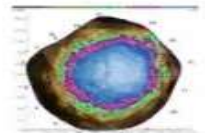
Stage 8 (end):
reduction and
reconstruction of
the crown

*Centripetal mortality
and cavitation*

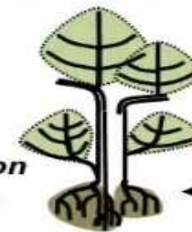


*Basipetal
mortality and
cavitation*

Stage 9:
reconstruction of
the crown



Stage 10:
reconstruction
of the tree



The Arthur Clough Oak/Signal Elm tree



1910



1920s



1953



1981



2009



2025

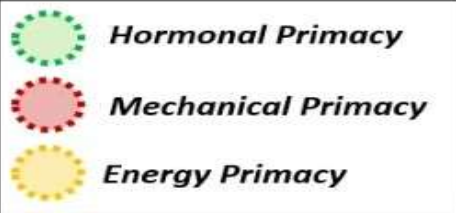
Images 1-5 collated by Philip Stewart, Image 6 added by James Chambers







The form as an expression of a dynamic balance



Phase III Adult
(stage 7-8)

Centrifugal mortality and heartwood

Centripetal mortality and cavitation

Phase IV: Mature
(stage 9)

Basipetal mortality and cavitation

Phase V: Old
(stage 10)

Acropetal mortality

Phase I: Infant
(stage 1-4)

Phase II: Young
(stage 5-6)

I: <u>Infant</u> (stage 1-4)	Growth in height (building the trunk)
II: <u>Young</u> (stage 5-6)	Growth in volume (building the crown)
III: <u>Adult</u> (stage 7-8)	Lasting in time (crown renewal)
IV: <u>Mature</u> (stage 9)	Lasting in time (crown reduction)
V: <u>Old</u> (stage 10)	Lasting in time (crown rebuilding)

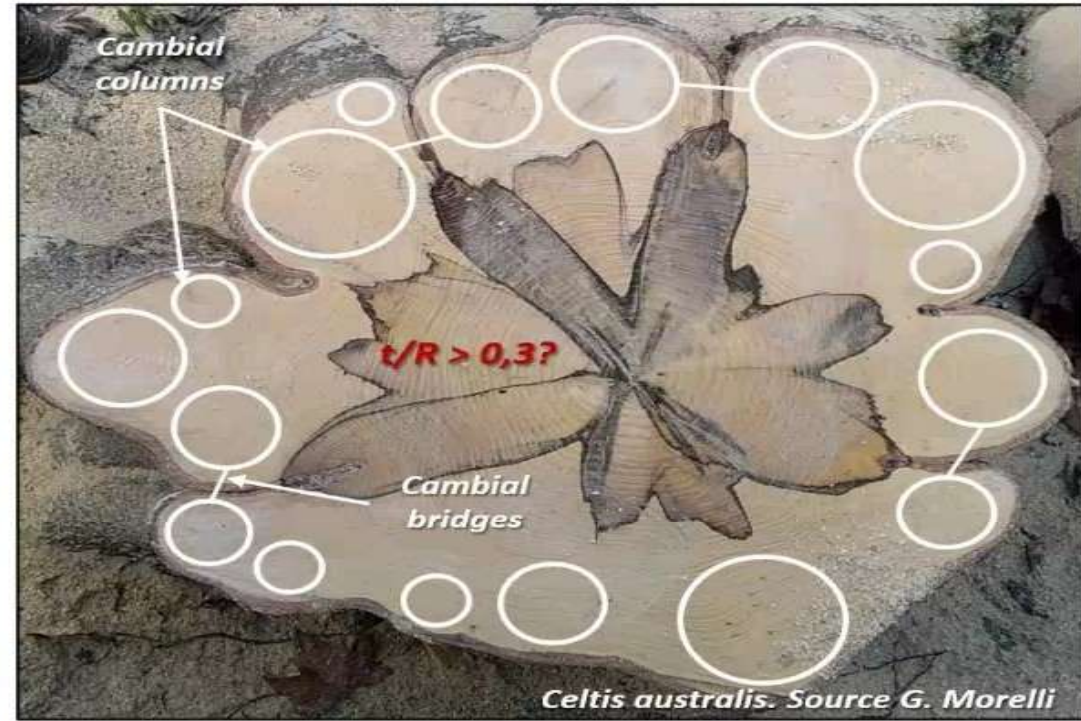
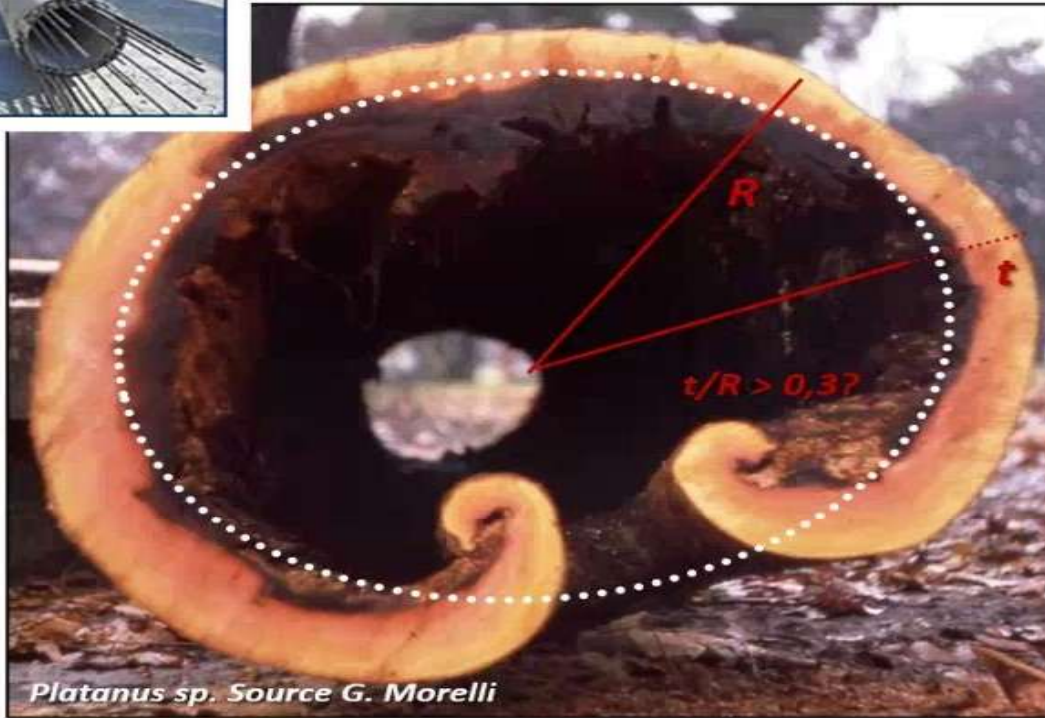
The sequence of morphophysiological stages can:

- Have stages with a variable duration;
- Be incomplete;
- Have Jump of stages;
- Have regressions of stages;

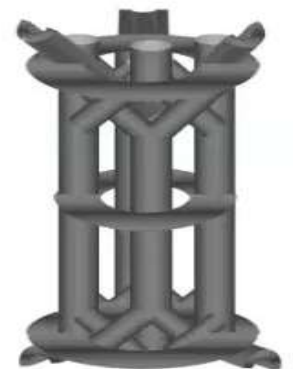
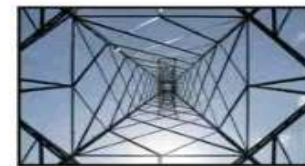
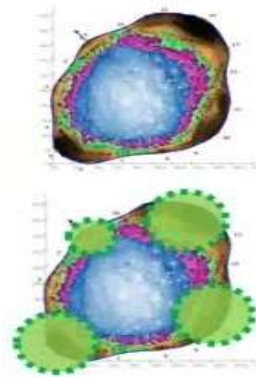
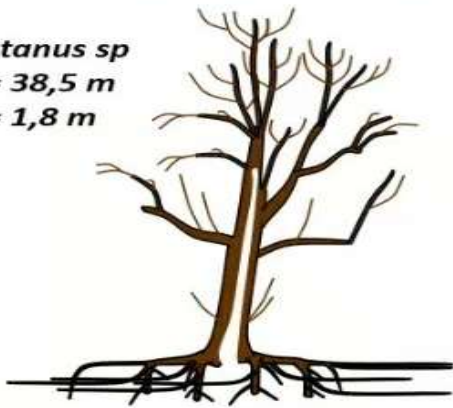




Structural implications of morphophysiological evolution of the stem



Platanus sp.
H = 38,5 m
D = 1,8 m

















Most Tree Don't
Make It

Will it bounce back?
Oak – Bruce Castle Park, Tottenham



Stage 8 Problem 1

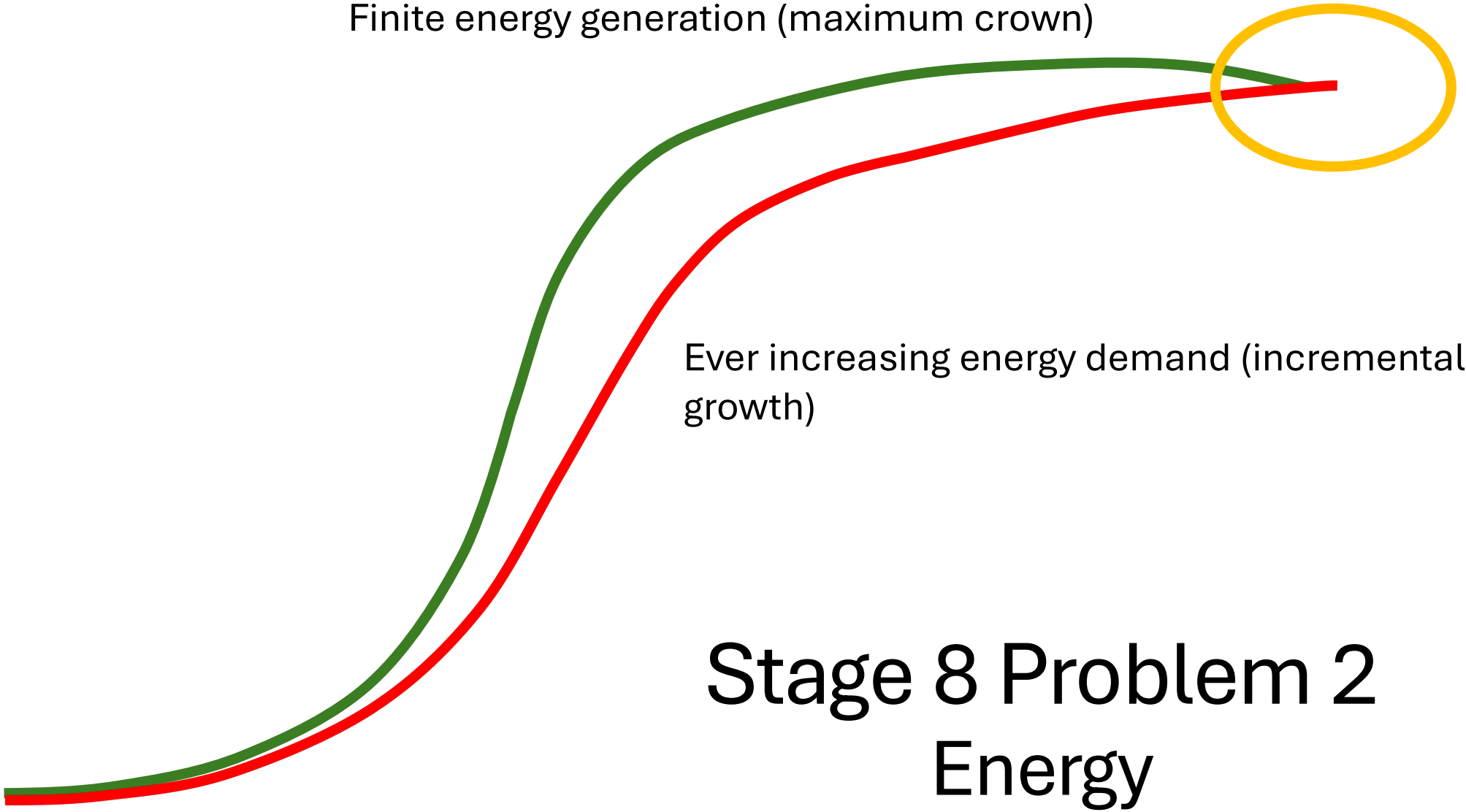
Hydrology

Increasing
Hydrological
Resistance
associated with
terminal bud scar
proliferation

Finite energy generation (maximum crown)

Ever increasing energy demand (incremental growth)

Stage 8 Problem 2
Energy



Survival Strategies

Clone

Veteran

Seed

Veteran Survival Strategies

ReCycle – Stage 8

Reorganisation – Stage 9

Fragmentation – Stage 10

Phoenix – Stage 10

Layering – various

**Maintaining existing
crown
(Stage 8)**

Chestnut Leaved Oak

2009

Kew Gardens

2026

Recycling Strategies

Leaves (leaf abscission)

Twigs (cladogenesis)

**Branches (branch failure
/abscission)**

Stem (heartrot)

**Roots (from root hairs to
structural roots)**



Stage 10 – Hornbeam Hatfield Forest, Essex

Cambial Columns v Annual Rings

Advanced cambial column formation following recycling of central heartwood

Reducing energy demand for incremental growth



Stage 10 – Hornbeam Hatfield Forest, Essex

Recycling Strategies



Twigs
(cladogenesis)



Branches
(branch abscission)

Reorganisation Strategies

Retrench to more compact crown (Stage 8)

Reiterate a new crown (Stages 8, 9 & 10)

**Retrench to more
compact crown**

Stage 8 Oak, Yorkshire





Stage 8 – Birch
Staverton, Suffolk

Retrenching birch

Stage 8 birch:

Showing early signs of crown retrenchment by basipetal crown mortality (“growing down”).

This retrenchment could be driven by drought or hydrological and energy stress from ageing (the Stage 8 Problem)

Reiteration Strategies

Delayed Total Reiteration (ontological model)

Traumatic Total Reiteration (real life)

Sprouting Basal Reiteration

Suckering Basal Reiteration

Fragmentation

Ontological

Stage 9



Stage 9

**Dying Stage 8?
Ontological Stage 9?
Stress Driven Stage 9?**



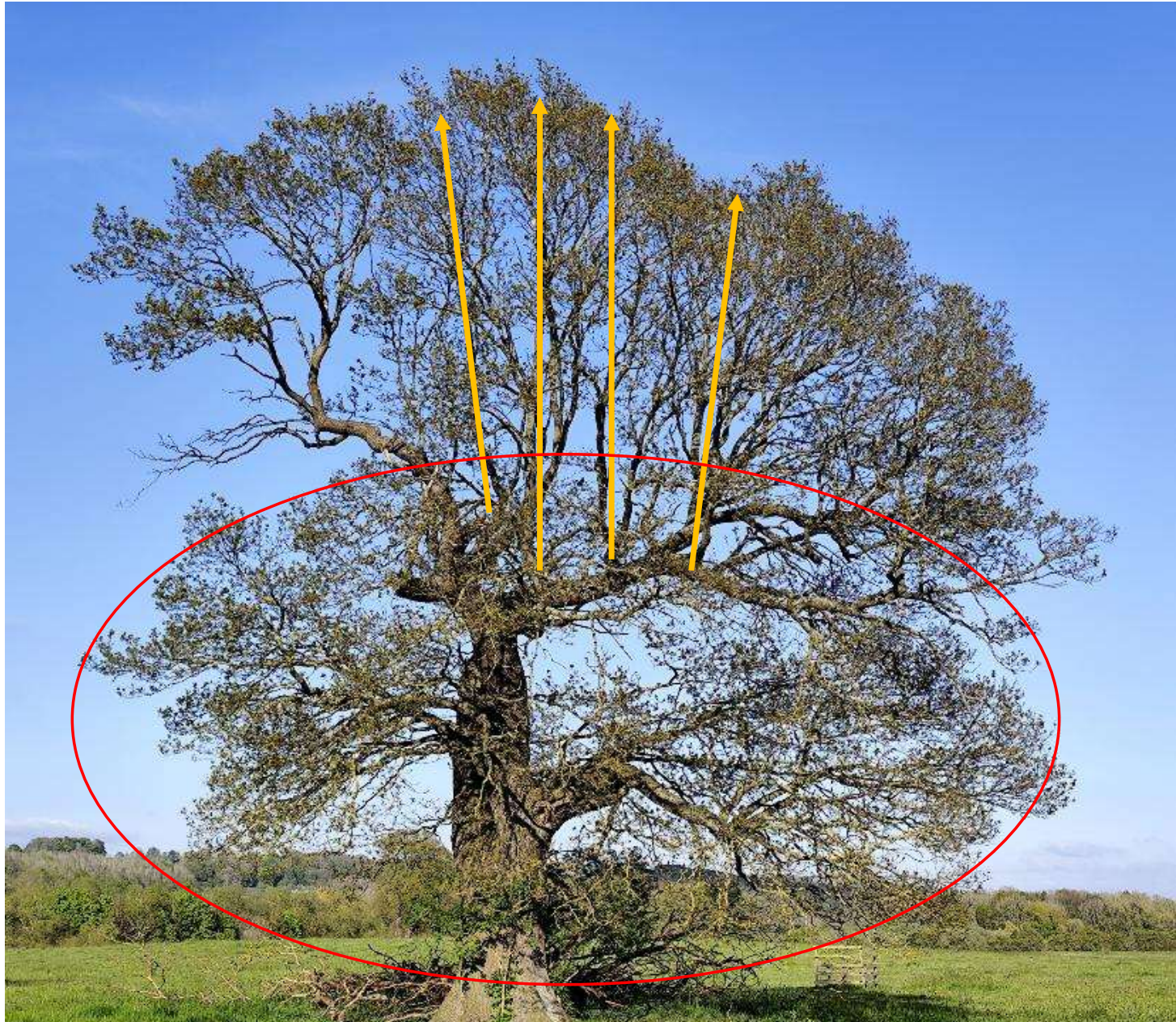
Oak – Hatfield Forest, Essex.

Traumatic Total Reiterations Natural Pollard

**Stage 8 bole with crown re-
organisation (Stage 6?)**

**Upper Crown of new
orthotropic epicormic A1
trunks (aka isotonic
traumatic total
reiterations).**

**Lower crown of remnant
branches and plagiotropic
epicormic (hypotonic
partial reiterations)**



Beech Pollards

Stage 8 ancient lapsed pollard beech. Reiterated (Stage 7) crown made up of traumatic total reiterated A1 trunks.

Process driven by pollarding producing mixed stages with the crown in an earlier life stage than the bole.

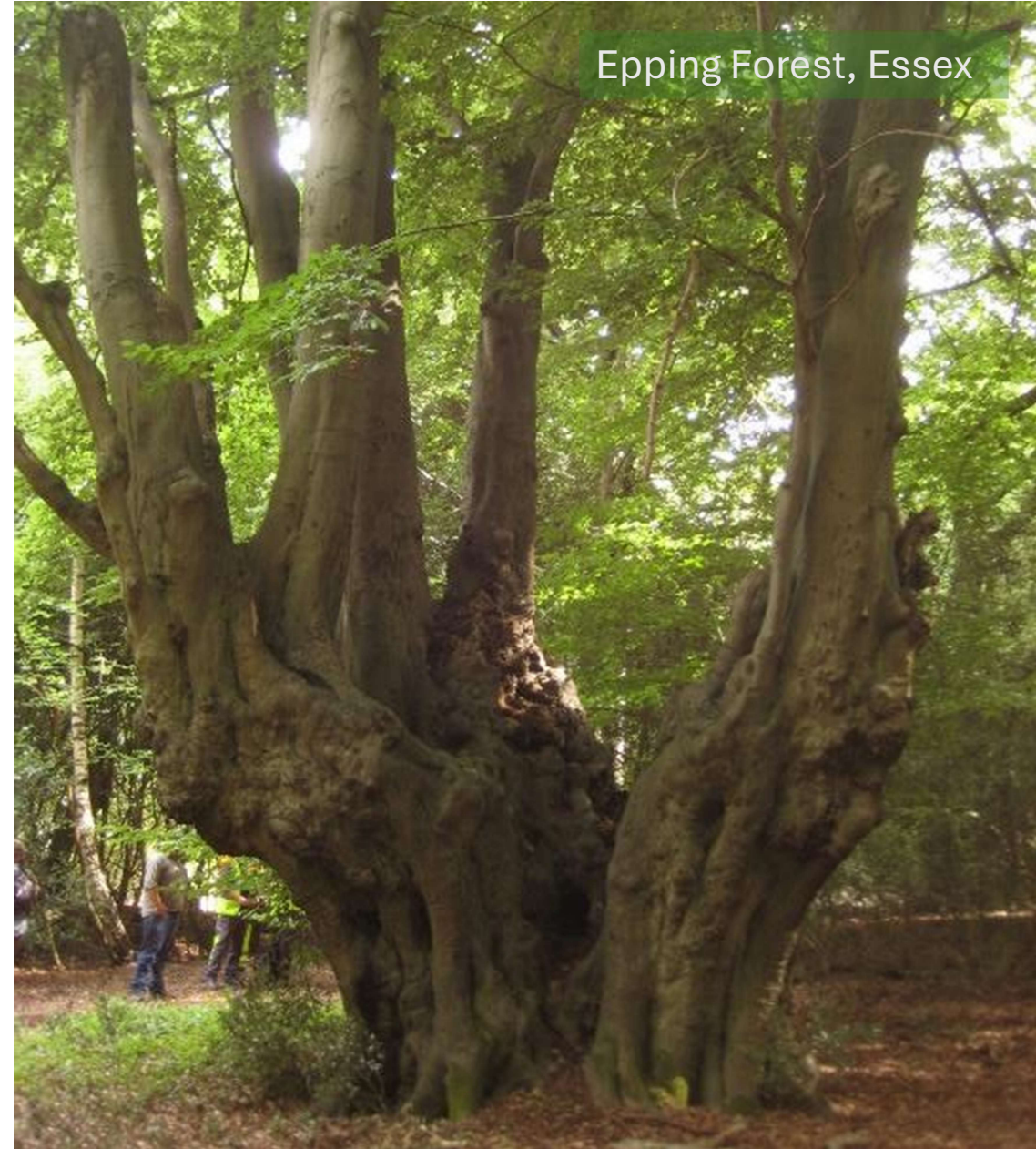


Dallington, East Sussex

Beech Pollards

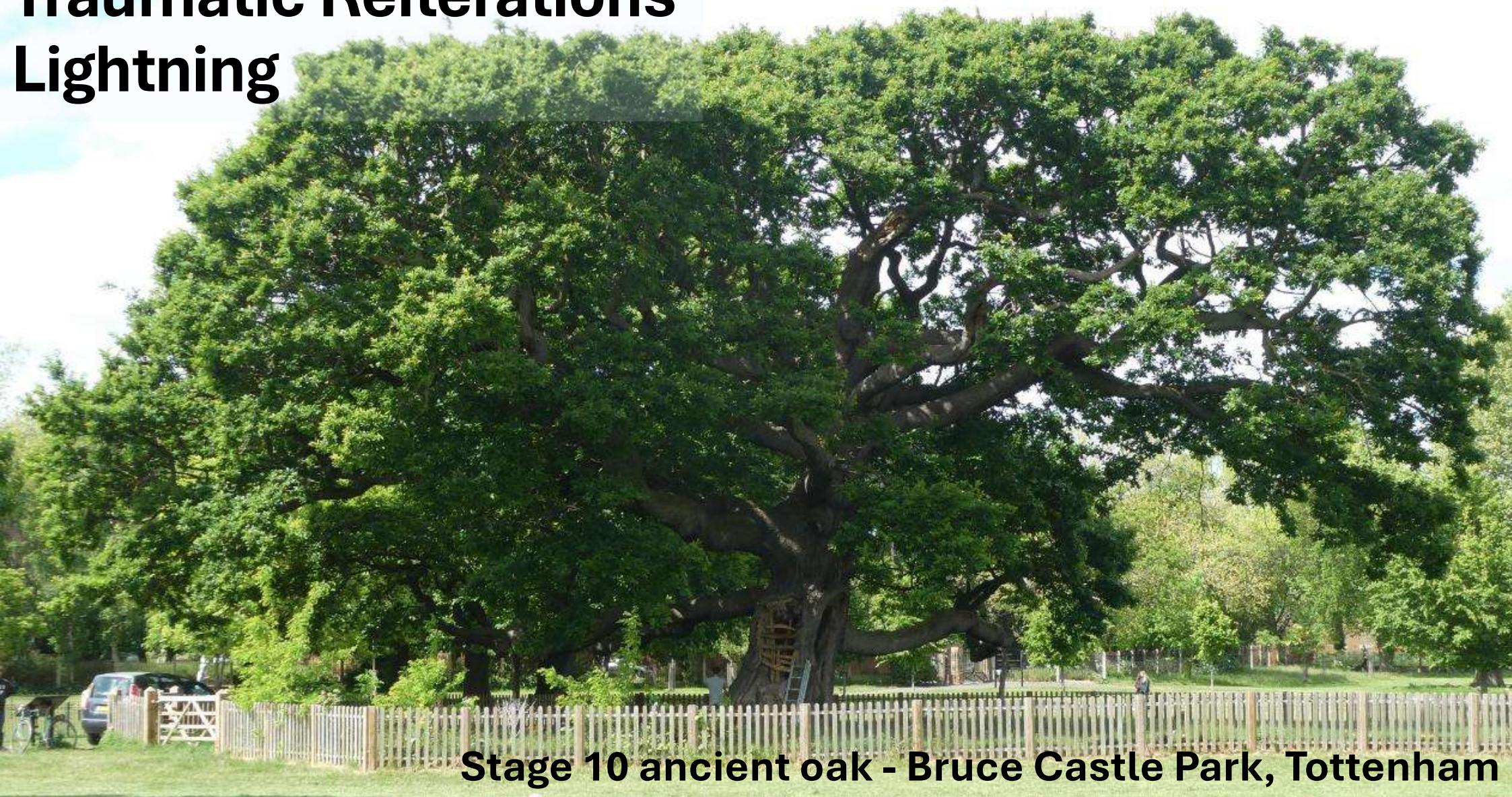
Stage 10 ancient lapsed pollard (coppard?) beech. Reiterated (Stage 8) crown made up of traumatic total reiterated A1 trunks.

Options for further crown or stem reorganisation appear very limited.



Traumatic Reiterations

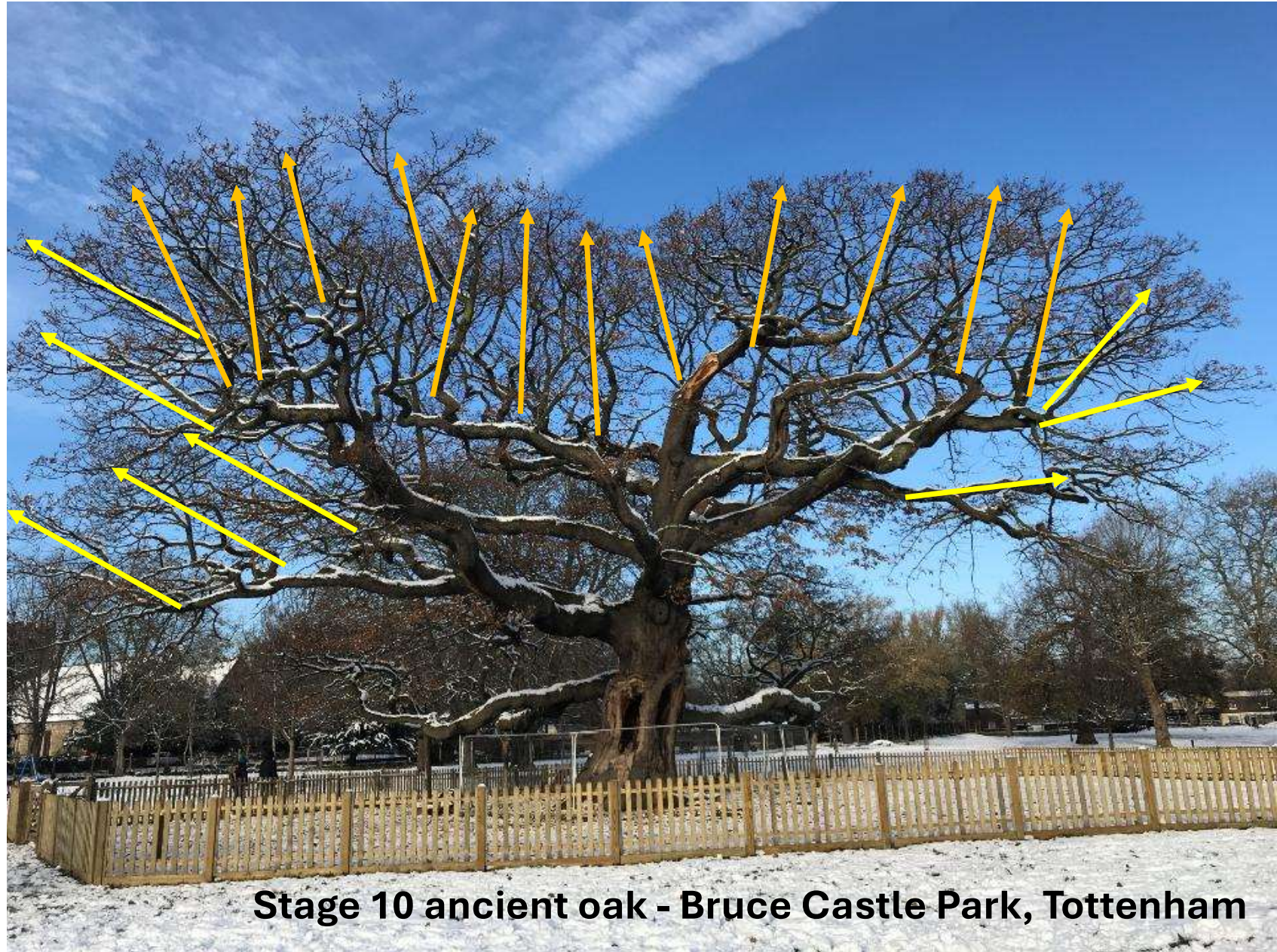
Lightning



Stage 10 ancient oak - Bruce Castle Park, Tottenham

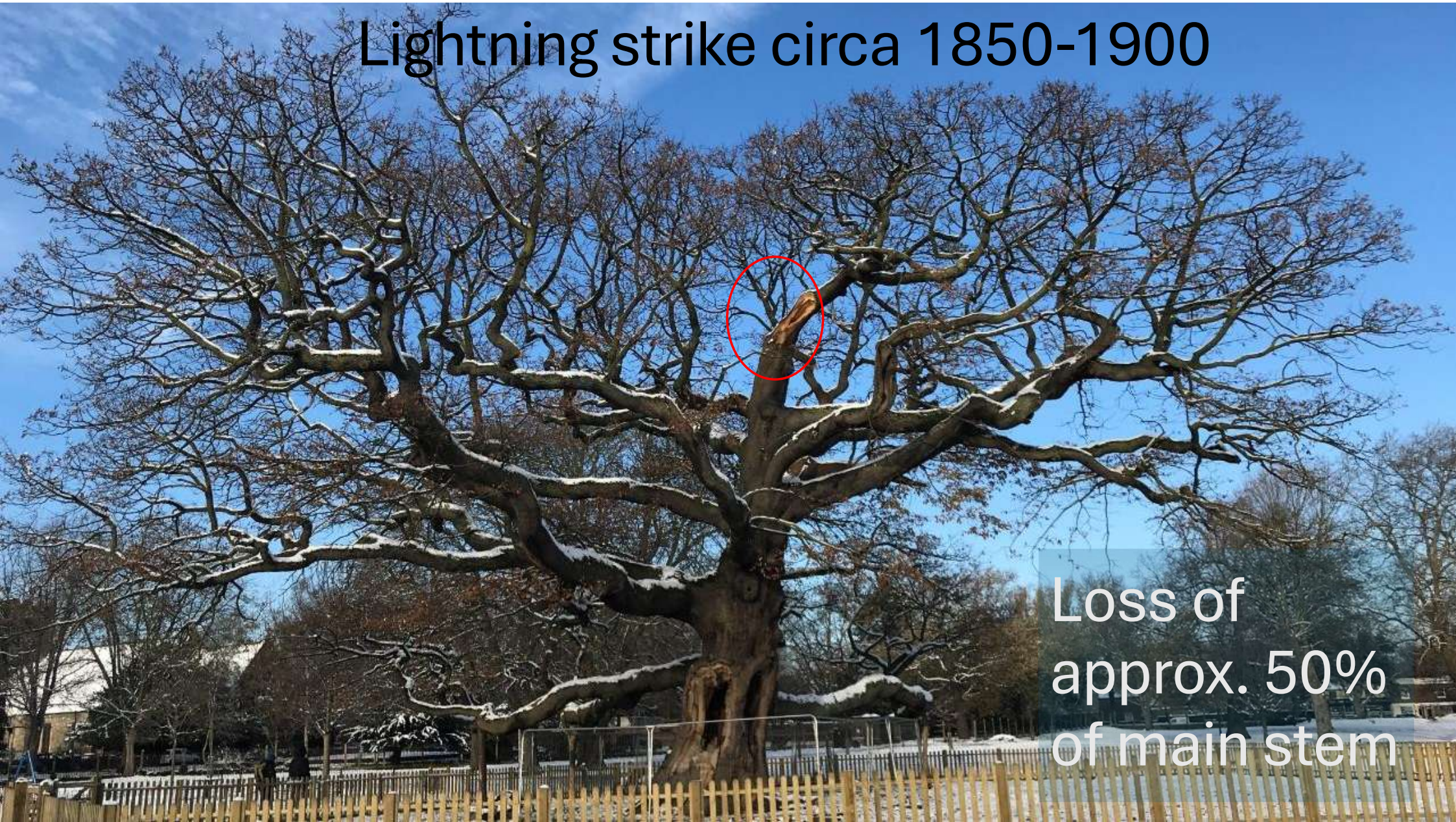
Orthotropic
A1 Isotonic
total
reiterations

Plagiotropic
A2
Hypotonic
partial
reiterations

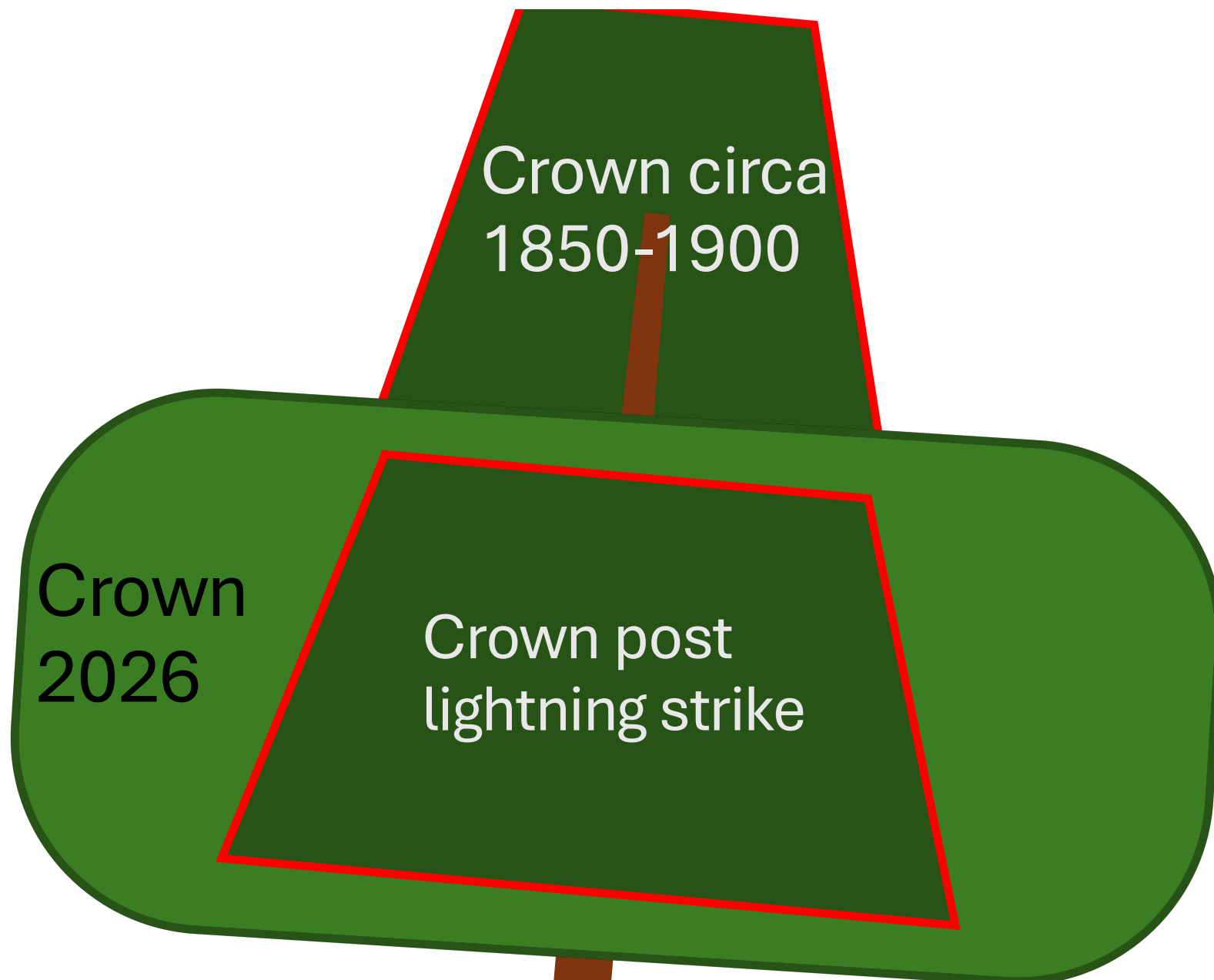


Stage 10 ancient oak - Bruce Castle Park, Tottenham

Lightning strike circa 1850-1900



Loss of
approx. 50%
of main stem



Crown circa
1850-1900

Crown
2026

Crown post
lightning strike

Crown 2026



Traumatic
Reiterations

Drought?

Multiple
crown
reiterations?



Stage 10 oak – Sherwood Forest

Traumatic
Reiterations

Drought?

Orthotropic
A1 Isotonic
total
reiterations



Sprouting Basal Reiteration

Reorganisation of the crown from the bottom up by means of vigorous A1 orthotropic epicormic total reiterations.

Common in Lime and Sweet Chestnut



Sprouting basal Reiteration

**Stage 10 Sweet Chestnut
NT Croft Castle, Herefordshire**



Sprouting Basal Reiteration

**Upper crown
retrenching but
lower reiterating
crown very
vigorous**

**Stage 8 & 9?
Sweet Chestnuts
Kew Gardens**



Suckering Reiteration

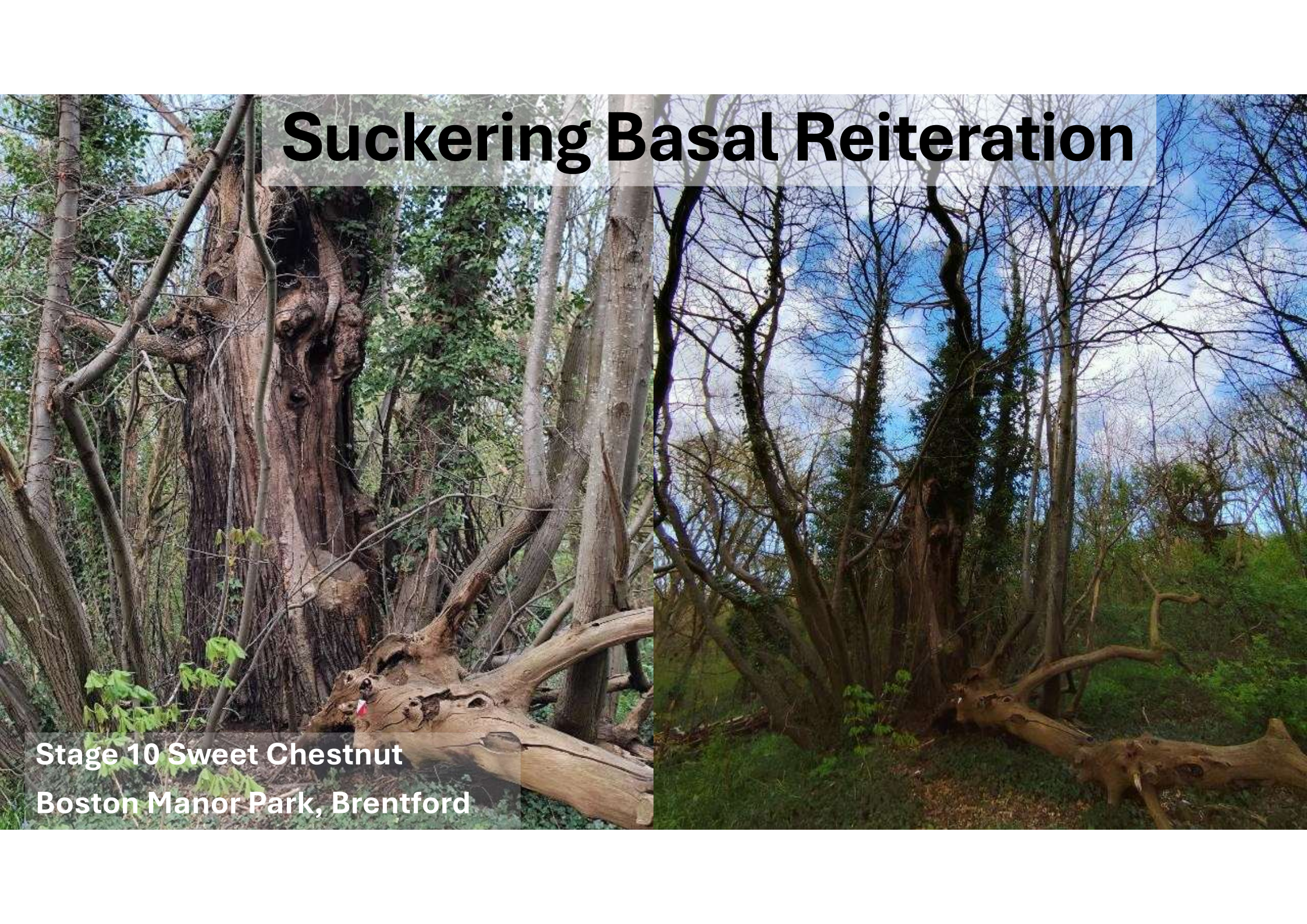
At late Stage 8 rather than reorganise the existing crown the tree's root system reiterates new vigorous A1 trunks. These could be called delayed external total reiterations because they originate from roots not branches or the main stem.

These new ramet A1s become dominant and usually lead to mortality of the original tree.

Differs from clonal ramets that create clonal copses or woodlands (genets) because they just replace one tree with a circle of suckers.

Frequent with chestnut, lime and some fruit trees. Rarely with hornbeam.

Suckering Basal Reiteration



Stage 10 Sweet Chestnut
Boston Manor Park, Brentford

Suckering Basal Reiteration

Stage 10
Hornbeam

Whitewebbs
Park



Dead Stump

Suckering Basal Reiteration



Stage 8
(Suppressed Stage 9)
Grafted Pear
Springfield Park, Hackney



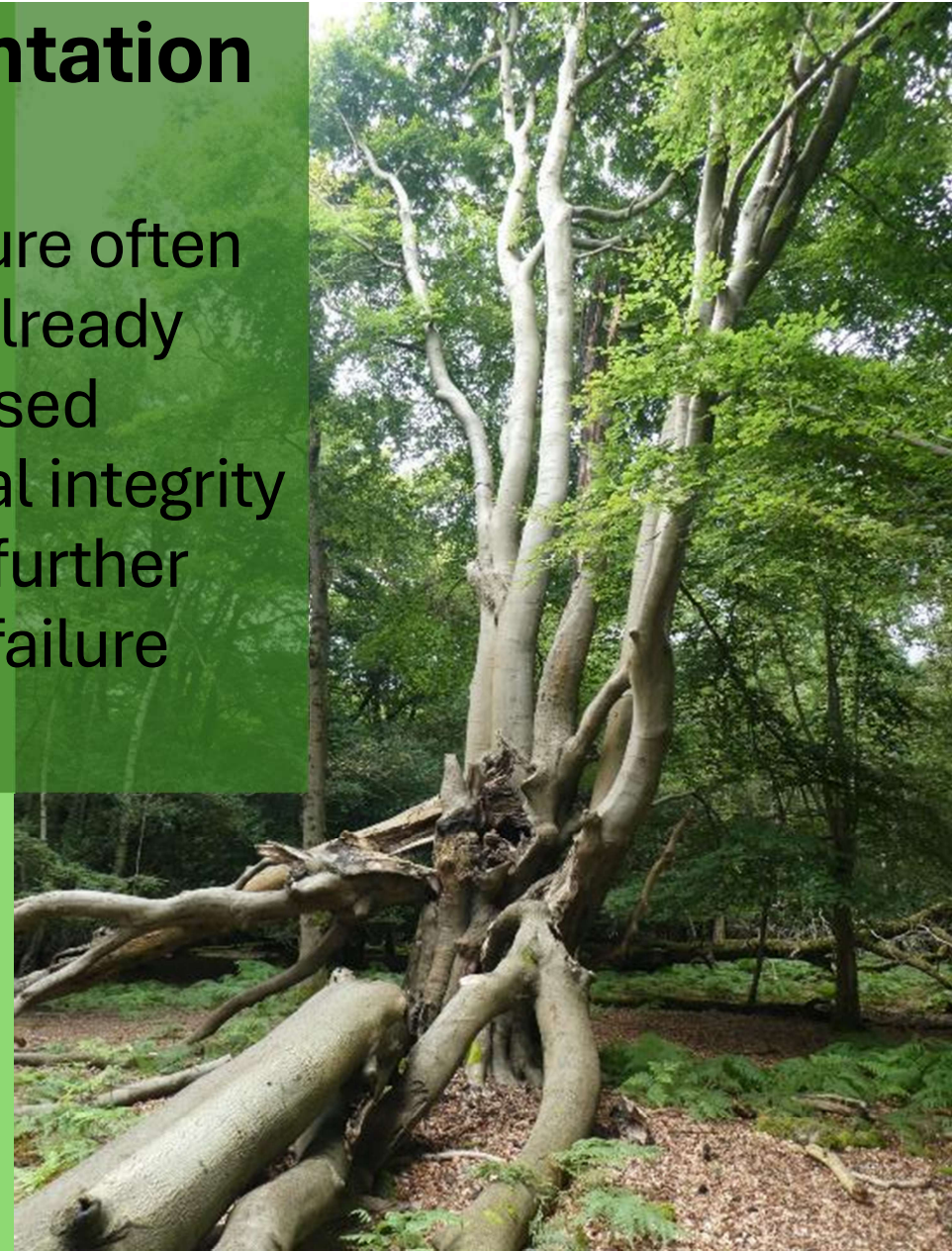
Fragmentation

Stage 10 ancient
beech with reiterated
crown and new stem
from one cambial
column



Fragmentation

Partial failure often weakens already compromised mechanical integrity leading to further complete failure





Fragmentation

But some partial failures can be survived or compartmentalised

Stage 10 - Sessile oak
Croft Castle, Herefordshire



Fragmentation

Some partial failures can be survived or compartmentalised

Stage 10 - Ancient hornbeam pollard remnant
Hatfield Forest

Phoenix Trees

(i.e. trees that live after falling)

solve the hydraulic and energy problems of late Stage 8 by losing their crowns and getting closer to the ground.

Phoenix Tree Characteristics

Abandon Heartwood

Defend new sapwood (Wall 4)

Flexible Sapwood

(most species can do it but common in Lime, Hornbeam, Birch)

Some root retention is crucial

Absence of grazing and shade essential



Phoenix birch

Stage 10 birch:

1. tree fell
2. replaced old crown with new total reiterations.

Each reiteration comes from an existing small branch or orthotropic epicormic shoots

(aka isotonic new A1 trunks)



Hainault Lodge, Redbridge

Phoenix Hornbeam

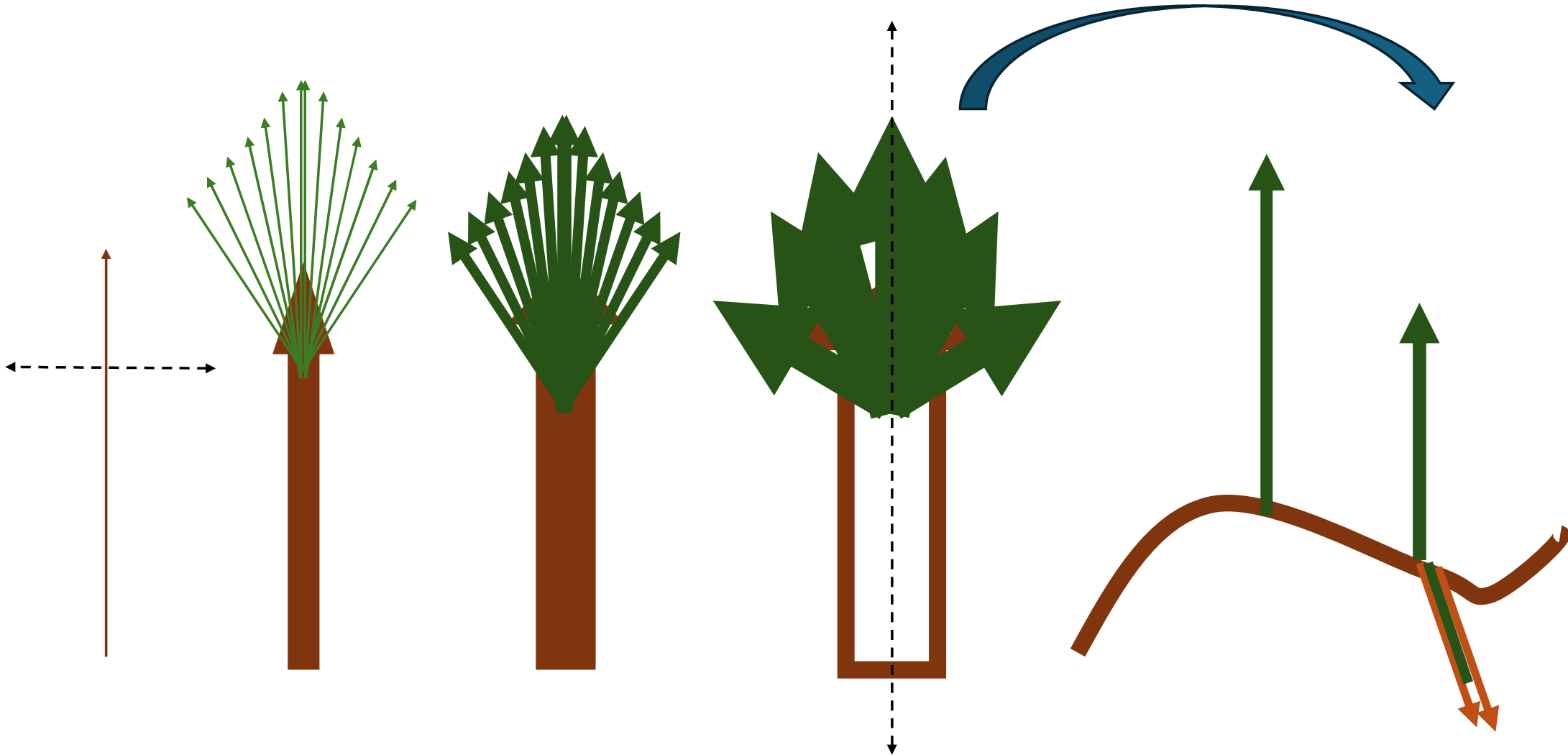
New crown
developing from
total reiterations
on failed pollard

Stage 10 Phoenix Hornbeam
Hatfield Forest, Essex



Stage 10 - Total reiteration of failed pollard
Hatfield Forest

Phoenix Hornbeam Pollard





Phoenix Sycamore

Stage 10 - Total
reiteration of failed
sycamore
Saltram House,
Devon

Layering Strategies

Developing New Roots from part of fallen section

Abandon Heartwood

Defend new sapwood (Wall 4)

Flexible Sapwood

(Hornbeam, Lime, Sweet Chestnut, Horse Chestnut, etc and Weeping cultivars)

Some root retention is crucial

Absence of grazing and shade essential



Walking Hornbeam

Stage 10 Hornbeam, Weald Country Park, Essex

Rolling Birch

Stage 10
Reiterating,
layering birch
slowly rolling
downhill



Stage 10 Birch, Western Highlands



Thank you for your attention!