Basics of Forest Damage

Diagnostics and Consequences

Johanna Witzell

Department of Forestry and Wood Technology

Linnéuniversitetet

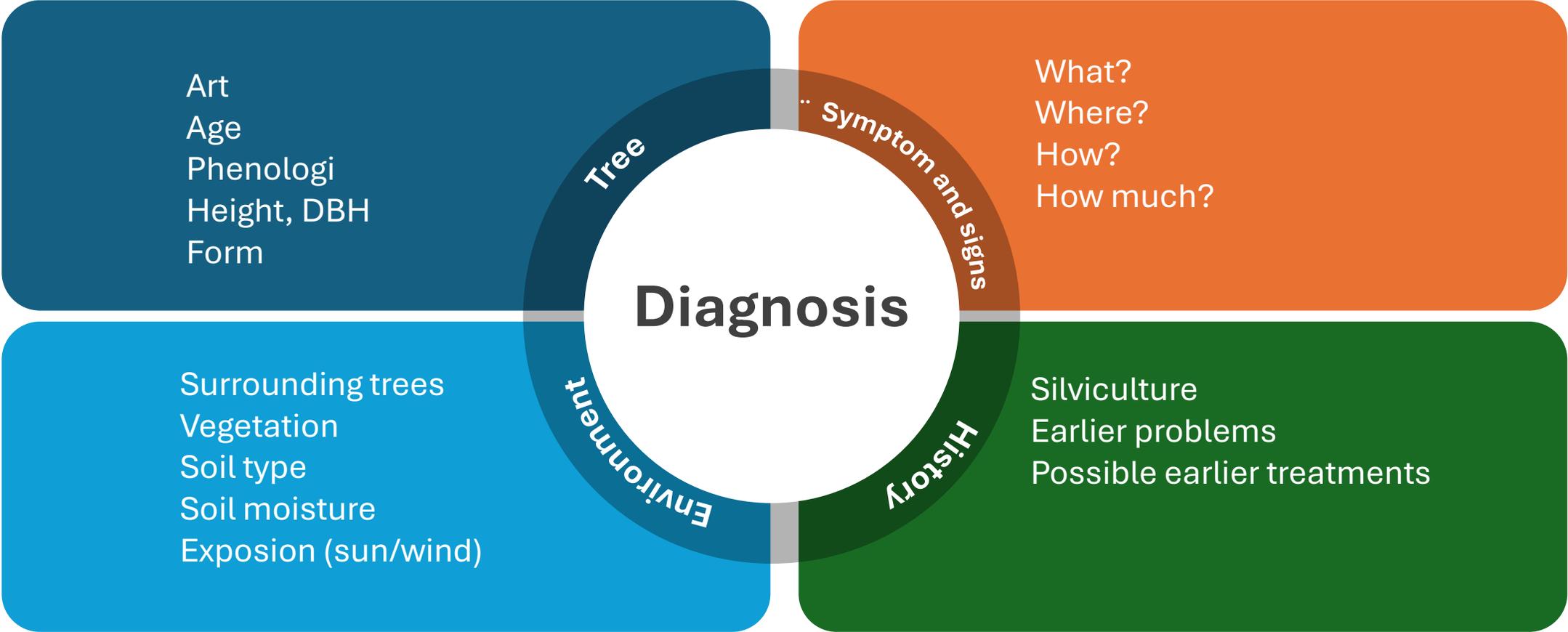*What is wrong with my tree?*

Symptom

The response of the tree

Signs

Signs of pathogens

Visual inspection

Systemic symptoms
(Whole tree or plant)

- *Chlorosis*
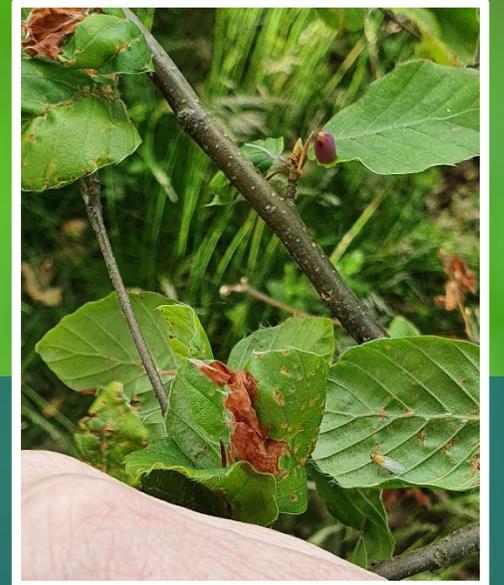- *Growth anomalies*
- *Wilting*

Local symptoms...

Cankers

Hyperplasia

"Dieback"

Antrachnosis

...more local symptoms

Epicormic shoots

Callus formation

Resin flow

Seed production

Etc.

Signs

Downy mildew

Leaf rust

Sooty moulds

Mining insects

Aphids

Fruiting bodies

Galleries

Exit holes

Planning the field inventory

1) Geographic area
2) Variations (t ex silviculture or site adaptation)
3) Inventory protocol

Frequency
Nr infected units/all units (e.g., plants)

Severity
Area/total area

Assessing the severity

- Actual measurements (e.g., area)
- Categories (0, <1, 1-25, 26-75, >75%)

4 categories

3 categories

High, medium and low vitality

Agostinelli et al. 2018   https://doi.org/10.3389/fmicb.2018.01758

Example: *Cryptostroma corticale* on *Acer pseudoplatanus*

Example of a protocol

10. Appendix I

10.1. Inventory Protocol

The observers name and date	Purpose of the inventory	Location, coordinates (SWEREF99)
Elevation (m above sea level)	Annual rainfall (mm)	Mean annual temperature (°C)

Variables	Units (quantitative variable) / Categories (categorical variables)
Scientific name	*Latin*
Estimated age	years
Settings	urban/woodland
Previous land use	1. agricultural land; 2. forested land; 3. field or meadow; 5. urban
Tree height	m
CBH	cm
Diameter of the crown	m
Light exposure	value 0–5 (e.g., a solitaire: 5 = four sides + crown)

Crown, vitality status	1. >80% vital; 2. 20–80% medium; 3. <20% low
Vegetation close to the tree, <5 m	1. herbs; 2. grass; 3. shrubs; 4. conifers; 5. deciduous trees; 6. other
Surrounding environment, <20 m	1. park; 2. roadside; 3. deciduous forest; 4. coniferous forest; 5. felling area; 6. field or meadow; 7. water; 8. buildings; 9. other
Coverage of lichens and bryophytes, <2 m height	1. 0–10%; 2. 11–30%; 3. 31–50%; 4. 51–70%; 5.71–100%
Tree damage (trunk)	1. no visible; 2. pruning; 3. digging; 4. collision; 5. other
Presence of bark injuries, <2m height	presence or absence
Fruit bodies	1. absence; 2. occurs on the ground, adjacent to the trunk of the tree; 3. occurs on the ground, under the crown of the tree; 4. occurs on the trunk of the tree; 5. other
Leaf damage	1. dark spots; 2. mildew; 3. insects; 4. rust; 5.no visible damage
Nature value	1. dead branches; 2. hollow; 3. barkless stem wood; 4. sap flow; 5. bird nest; 6. other no; 7. visible values
Signs and symptoms from pathogens or pests	presence or absence
General comments	

Pershagen, K. 2021: Vitality of Sycamore maple (*Acer pseudoplatanus*) in western Skåne, Sweden

Sampling

Think about:

- Start with statistics!
- It should be simple, repeatable, reliable
- What is "a sample" and how many are needed/is reasonable to collect
- How – random sampling (N.B. root damage can occur in patches)
- Is a preliminary study needed?
- Next step (analysis and reporting)

Basic equipment

01 Macro in the camera

02 Knife (and alcohol/Chlorine)

03 Planting trowel (soil samples)

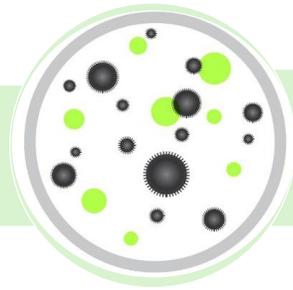**04** Cans/bags for samples and pens for marking

05 Notebook

To confirm causality: Koch's postulates

1.

The suspected pathogen should be present in every case of the disease but not in healthy ones.

2.

The microbe must be isolated from a diseased organism and grown in pure culture

3.

When the isolated pathogen is introduced to a healthy, susceptible host, it should cause the same disease that was observed in the original host.

4.

The pathogen should be re-isolated and shown to be the same as the original organism isolated from the initial diseased host

- *Disease is not the result of the mere presence of a microbe*

"...i.e. its presence is not a sufficient condition to cause disease: <mark>inoculum load ....is also critical</mark>, meaning it may be present in asymptomatic tissues but at significantly lower titers than in symptomatic material. In other words, presence of a microbe may be necessary, but in itself insufficient to cause disease. "

Bonello (2024) Complex Forest Tree Diseases – Diagnostics Beyond Koch's Postulates. Curr. For. Rep. (2024). https://doi.org/10.1007/s40725-024-00220-w

Challenges - Koch's postulates

Some organisms are simply not culturable
Declines – not just one cause

"In this condition, trees typically lose vigor over an extended period of time (a few to several years) in a way that is clearly different from normal senescence. Under decline conditions, trees display characteristic crown dieback symptoms, early leaf drop, wilting, and heart decay, leading to extensive tree mortality over large swaths of landscape. "

Bonello (2024) Complex Forest Tree Diseases – Diagnostics Beyond Koch's Postulates. Curr. For. Rep. (2024). https://doi.org/10.1007/s40725-024-00220-w
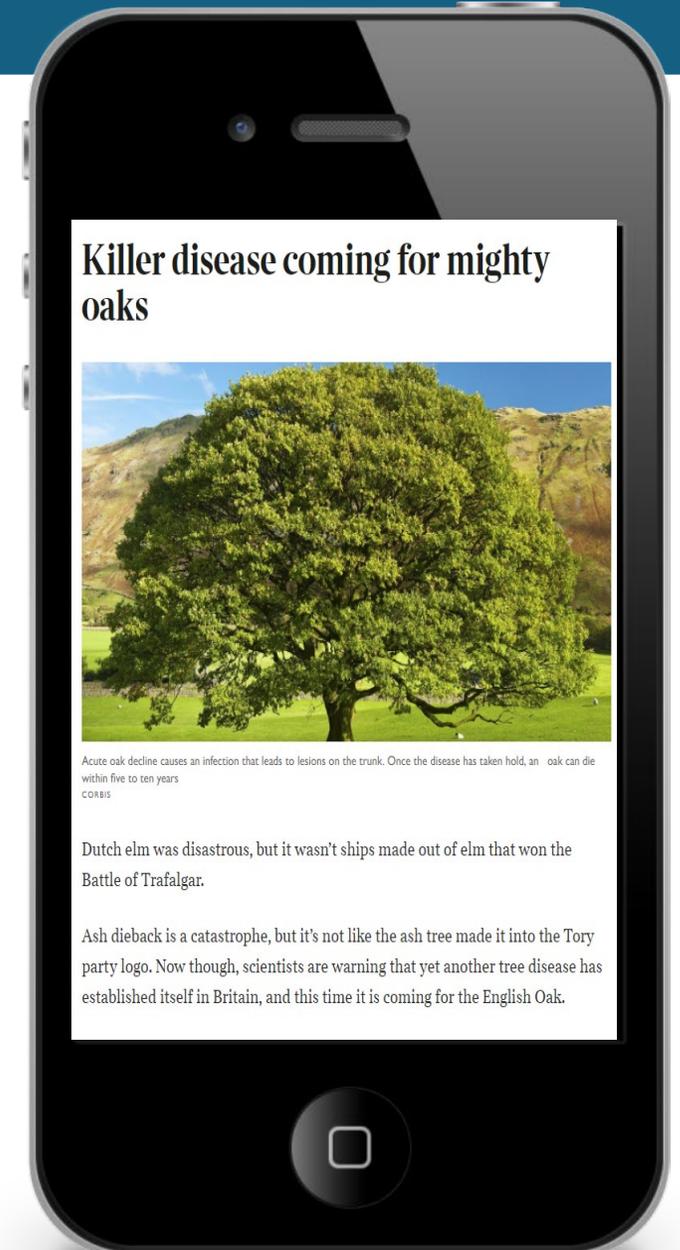
Killer disease coming for mighty oaks

Acute oak decline causes an infection that leads to lesions on the trunk. Once the disease has taken hold, an oak can die within five to ten years
CORBIS

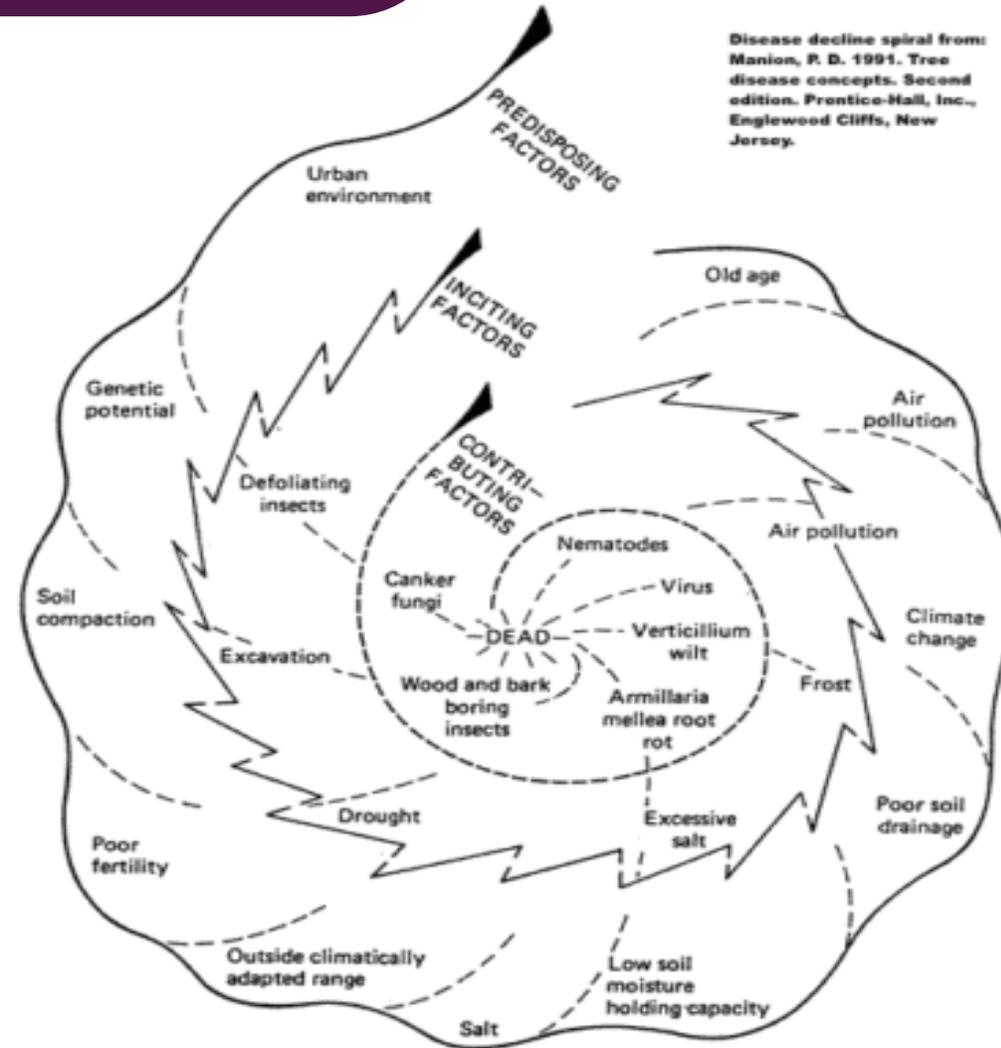Dutch elm was disastrous, but it wasn't ships made out of elm that won the Battle of Trafalgar.

Ash dieback is a catastrophe, but it's not like the ash tree made it into the Tory party logo. Now though, scientists are warning that yet another tree disease has established itself in Britain, and this time it is coming for the English Oak.
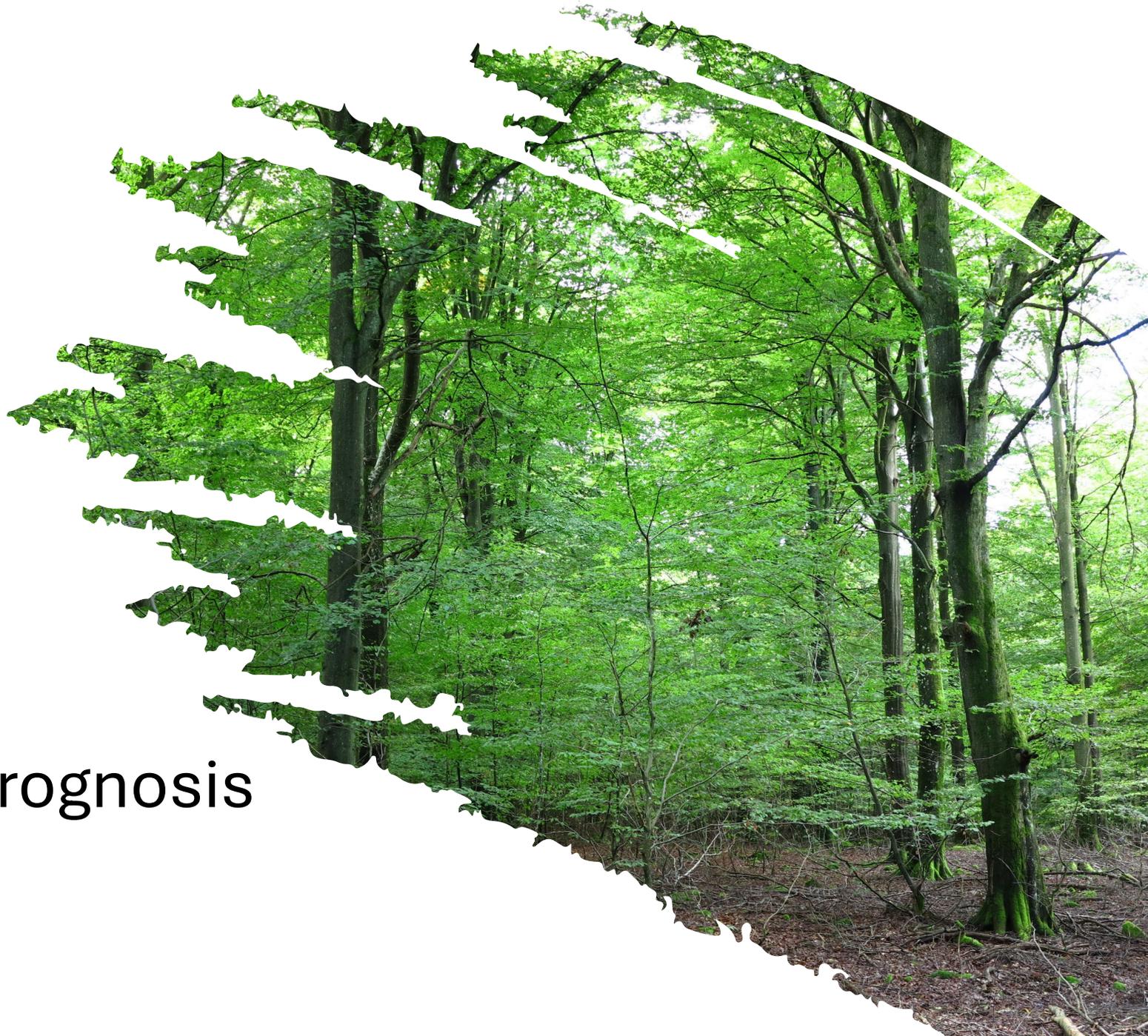
Paul Manion's model:
declines are the result of a successional series of factors impacting trees in a given locale:

(1) **predisposing**, i.e. long term, factors (e.g. climate change, poor soil quality, prolonged droughts),
(2) **inciting**, i.e. short term, factors (e.g. summer defoliation by an insect, seasonal excessive precipitation), and
(3) **contributing factors**, i.e. the *probable* (eventual) tree killers (e.g. root disease, attack by a wood boring insect).

Disease decline spiral from: Manion, P. D. 1991. Tree disease concepts. Second edition. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

PREDISPOSING FACTORS

INCITING FACTORS

CONTRI-BUTING FACTORS

Urban environment
Old age
Air pollution
Genetic potential
Defoliating insects
Air pollution
Nematodes
Canker fungi
Virus
Soil compaction
DEAD
Verticillium wilt
Climate change
Excavation
Wood and bark boring insects
Armillaria mellea root rot
Frost
Drought
Excessive salt
Poor soil drainage
Poor fertility
Outside climatically adapted range
Low soil moisture holding capacity
Salt

Acute Oak Death (AOD)
Bacteria, Insects, Environment
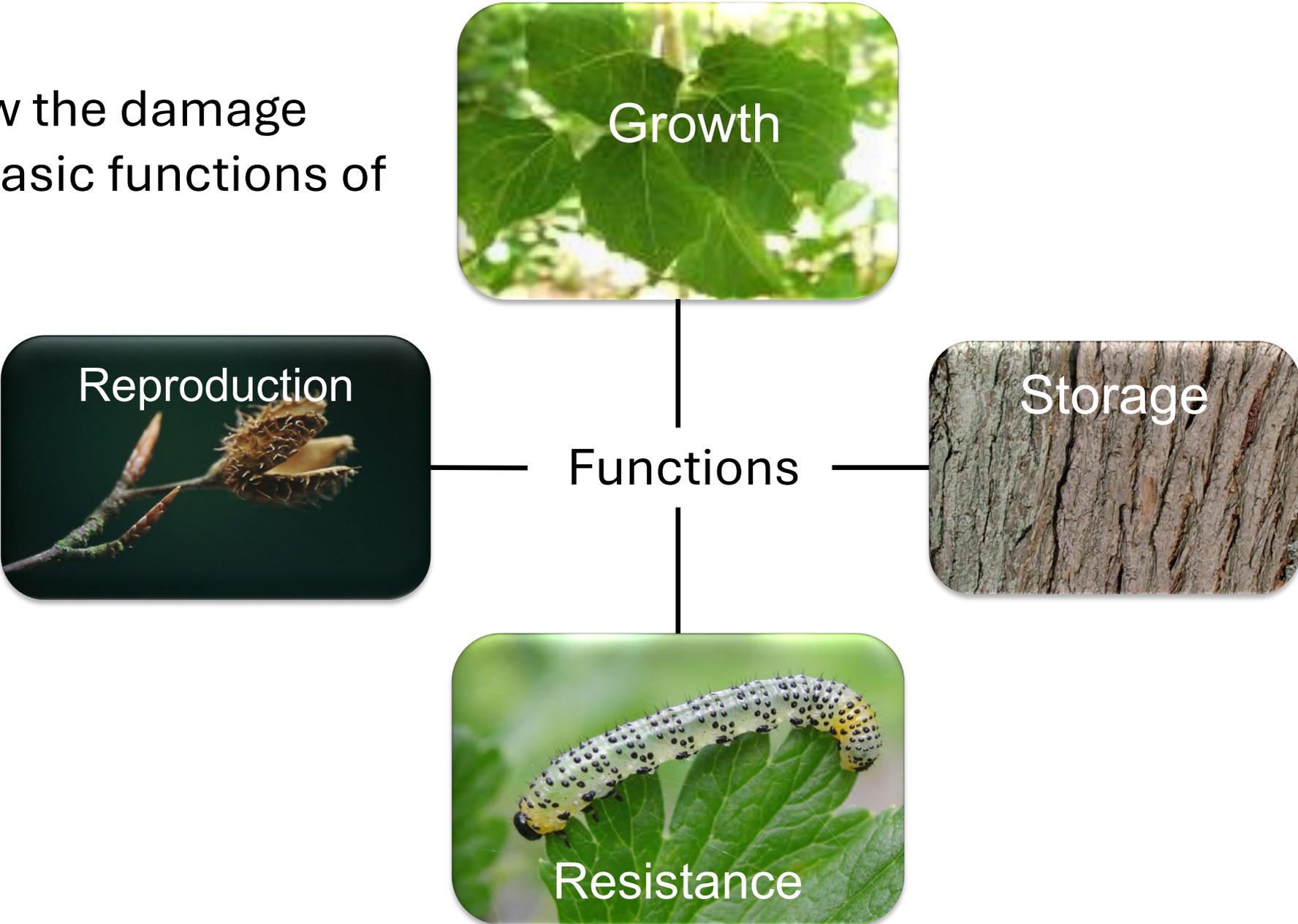
From diagnosis to prognosis

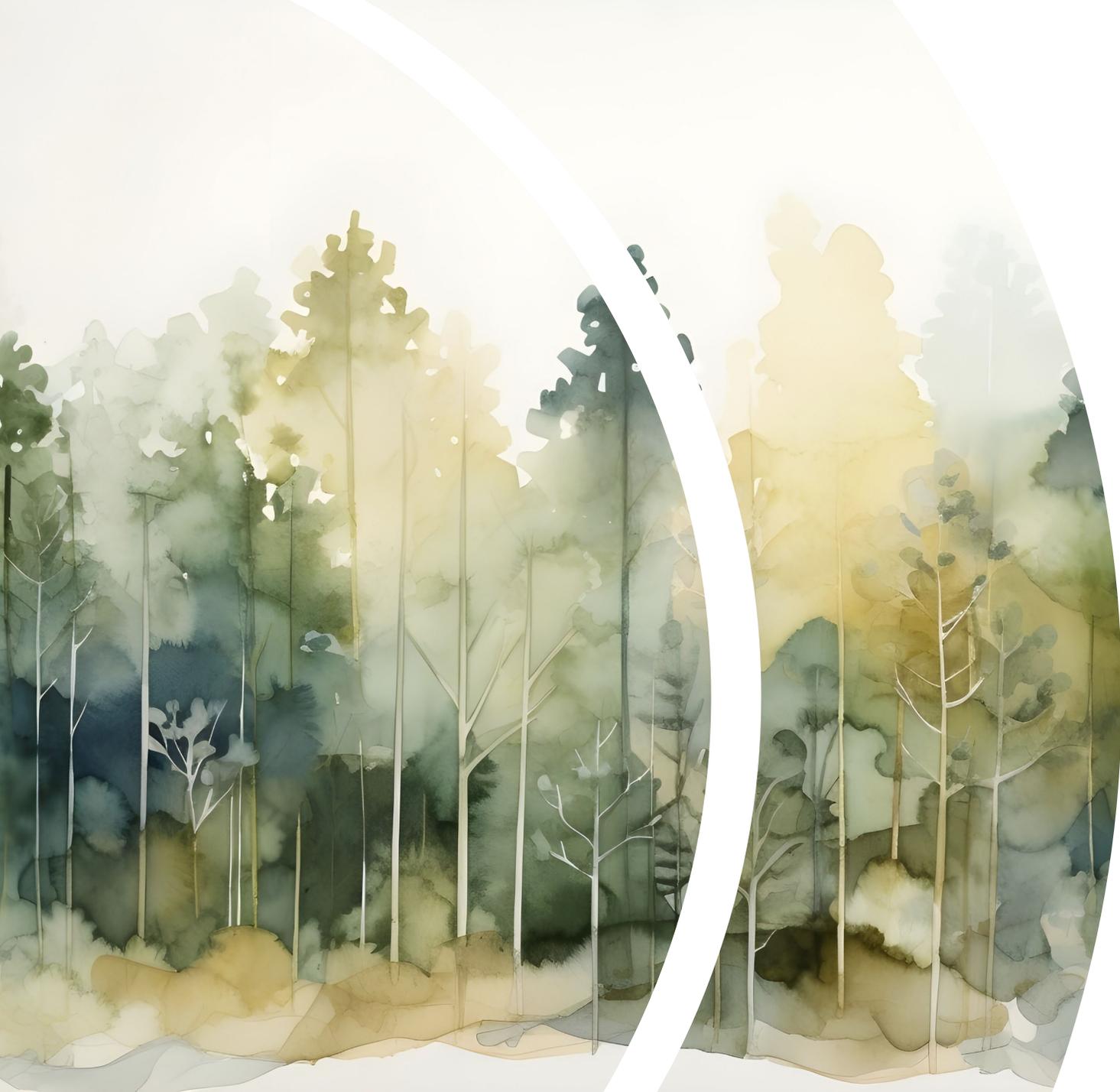What will happen to the tree?

What will happen to the forests?

Damage can be something from cosmetic to lethal

Evaluate how the damage affects the basic functions of trees

Growth

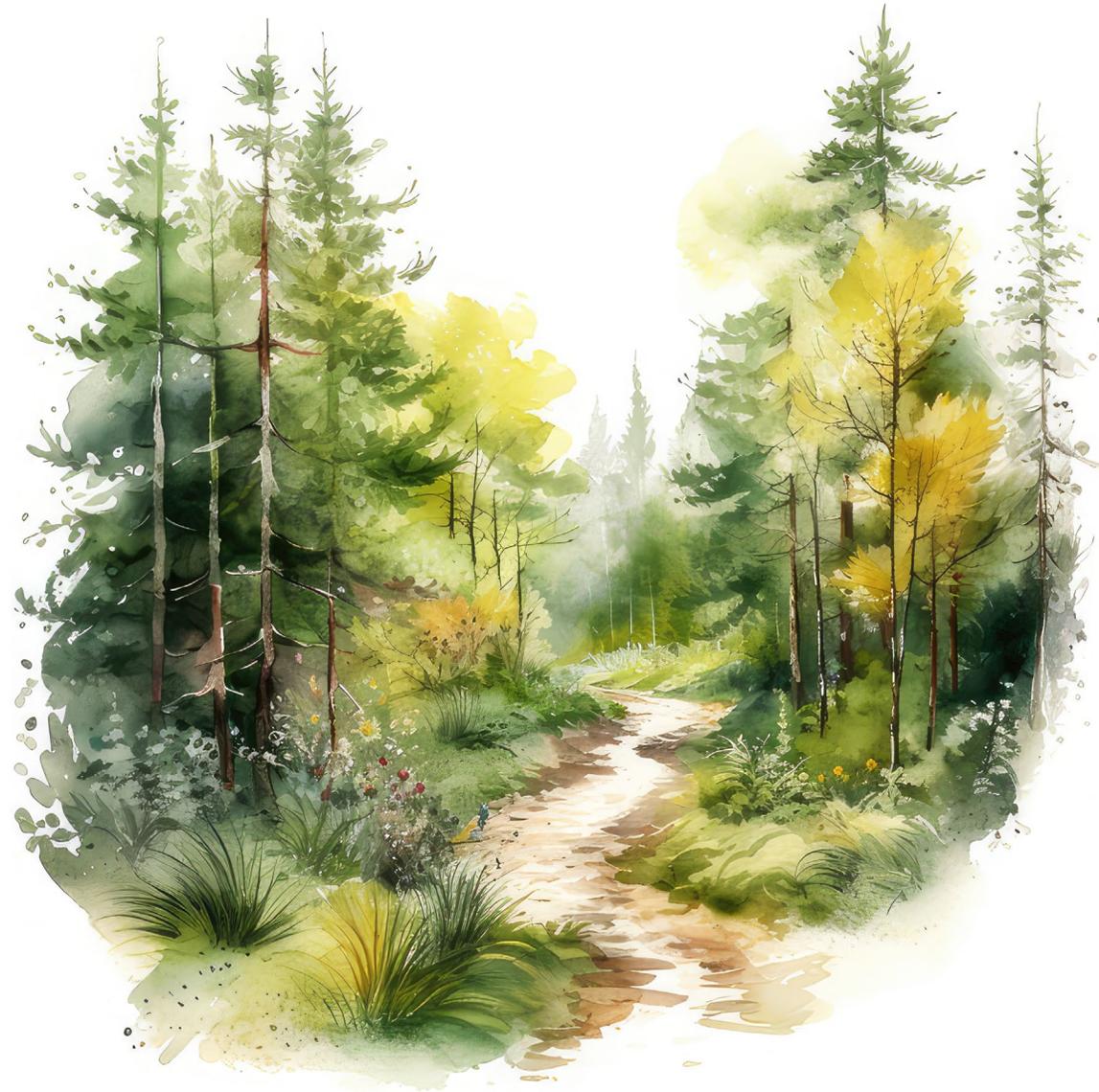Reproduction

Functions

Storage

Resistance

The challenging control of forest pests and pathogens

Forests:

- Large scales
- Long time horizon

Early detection and diagnosis is needed for eradication and containment
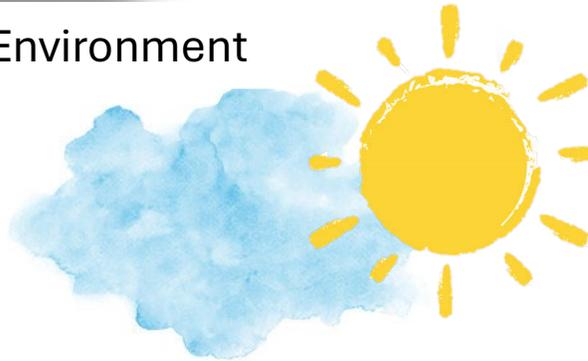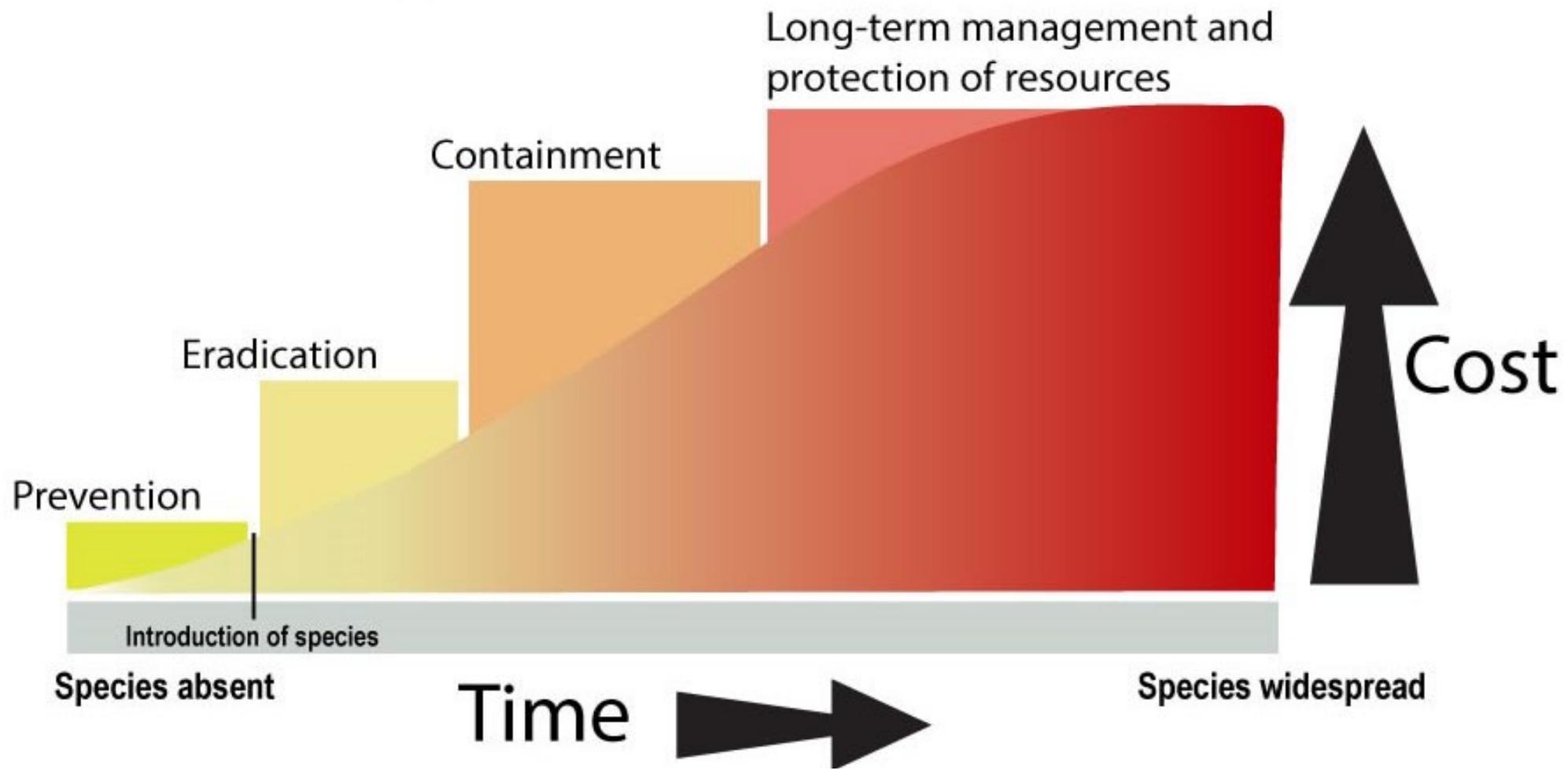
Proactive responses would be better than responses!

Time

Tree
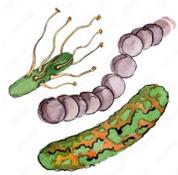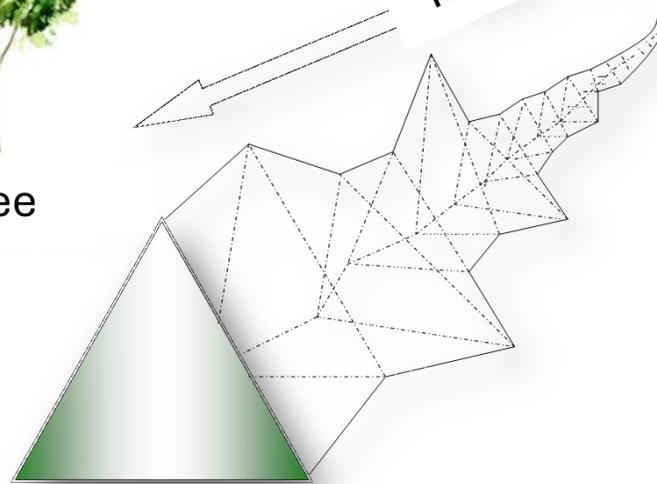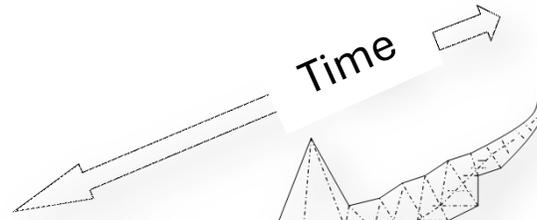
Pests

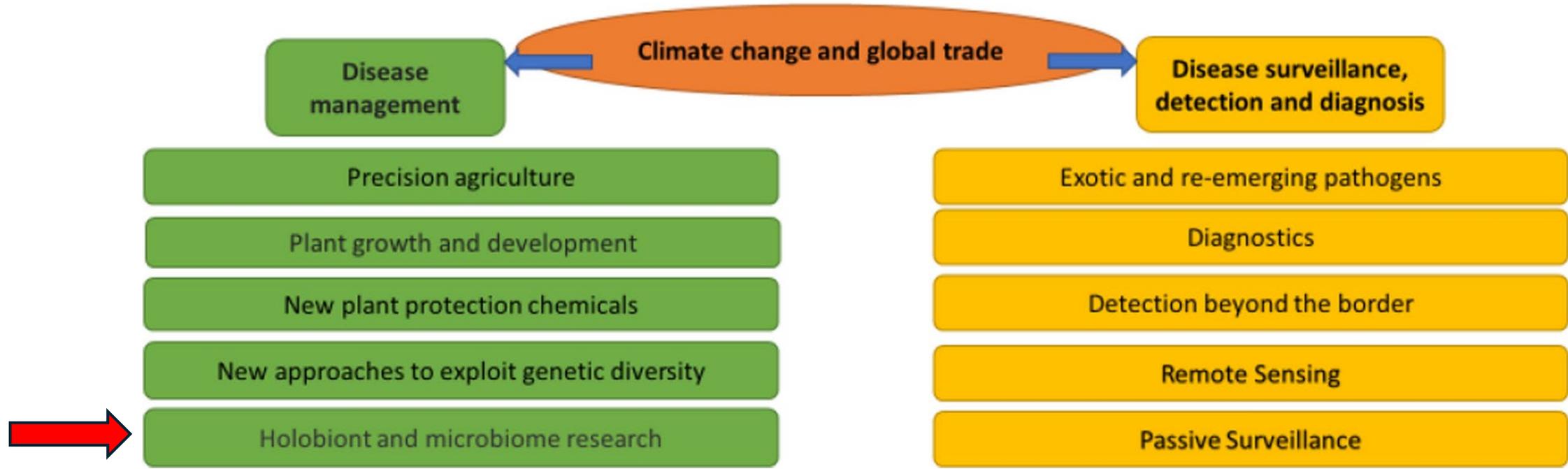Environment

Dynamic interaction
- difficult to know!

Long-term management and protection of resources

Containment

Eradication

Prevention

Introduction of species

Species absent

Cost

Time

Species widespread

Jeger, M., Beresford, R., Bock, C. *et al.* Global challenges facing plant pathology: multidisciplinary approaches to meet the food security and environmental challenges in the mid-twenty-first century. *CABI Agric Biosci* **2**, 20 (2021). https://doi.org/10.1186/s43170-021-00042-x

Diversity

Can we learn to create "ecological firewalls" against pests using:

- Species diversity
- Genetic diversity
- Structural diversity
- Nature-based solutions (NBS)

From NBS to NBT

The concept of **Nature-based Thinking** embodies the perspective of nature with people, rather than just nature for people.

Randrup et al. Urban Ecosystems (2020) 23:919–926

Thank you!

Contact: *johanna.witzell@lnu.se*

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