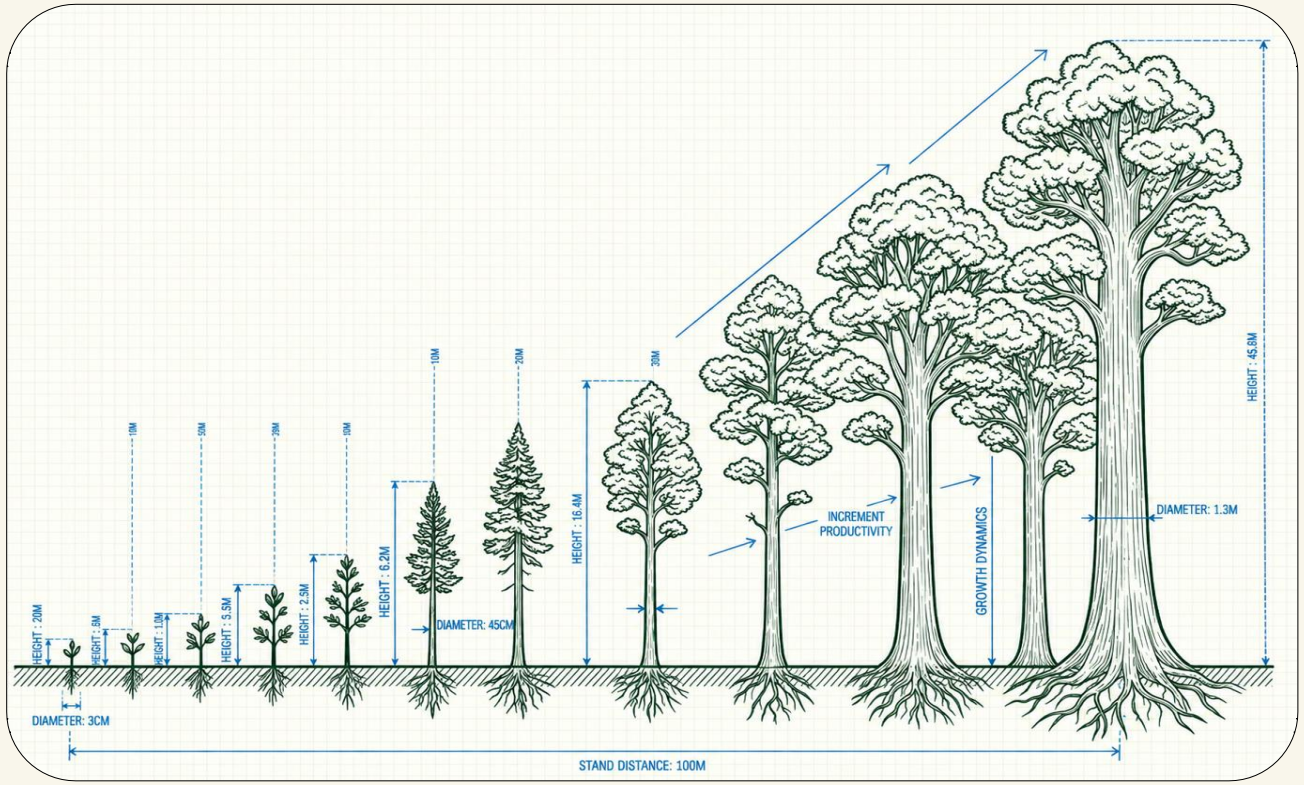
MEASURING THE FOREST GROWTH-

Understanding Stand Growth & Increment

How do we measure whether a forest is growing well?

BIG IDEA

Forest productivity is not only about tree size. It is about how quickly the stand adds volume over time.

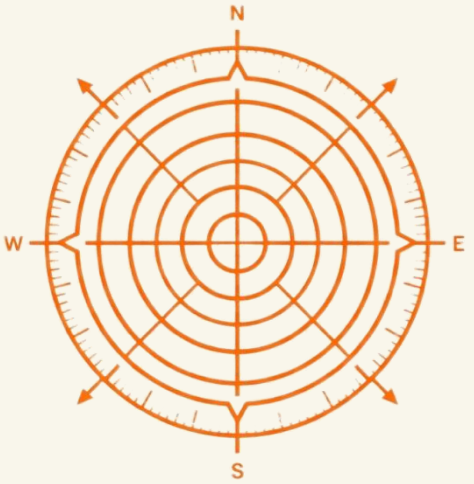


Learning Objective

By the end of this topic, learners should be able to explain stand growth and increment.

You should be able to:

1. Explain how forest growth changes with age.
2. Differentiate growth from increment.
3. Describe Current Annual Increment (CAI) and Mean Annual Increment (MAI) in simple terms.
4. Use growth curves to support forest management decisions.



REMEMBER

An increment is the rate of change. It helps us measure productivity.

Growth and Increment Are Different

Both terms describe change, but they do not mean the same thing.

GROWTH

The total biological increase in tree or stand size over time.

Example: a tree becomes taller and thicker.

INCREMENT

The amount or rate of growth during a specific period.

Example: a stand adds 8 m^3 of volume in one year.

KEY POINT

Growth is the result. Increment is the rate or amount added over time.

The Cumulative Growth Curve

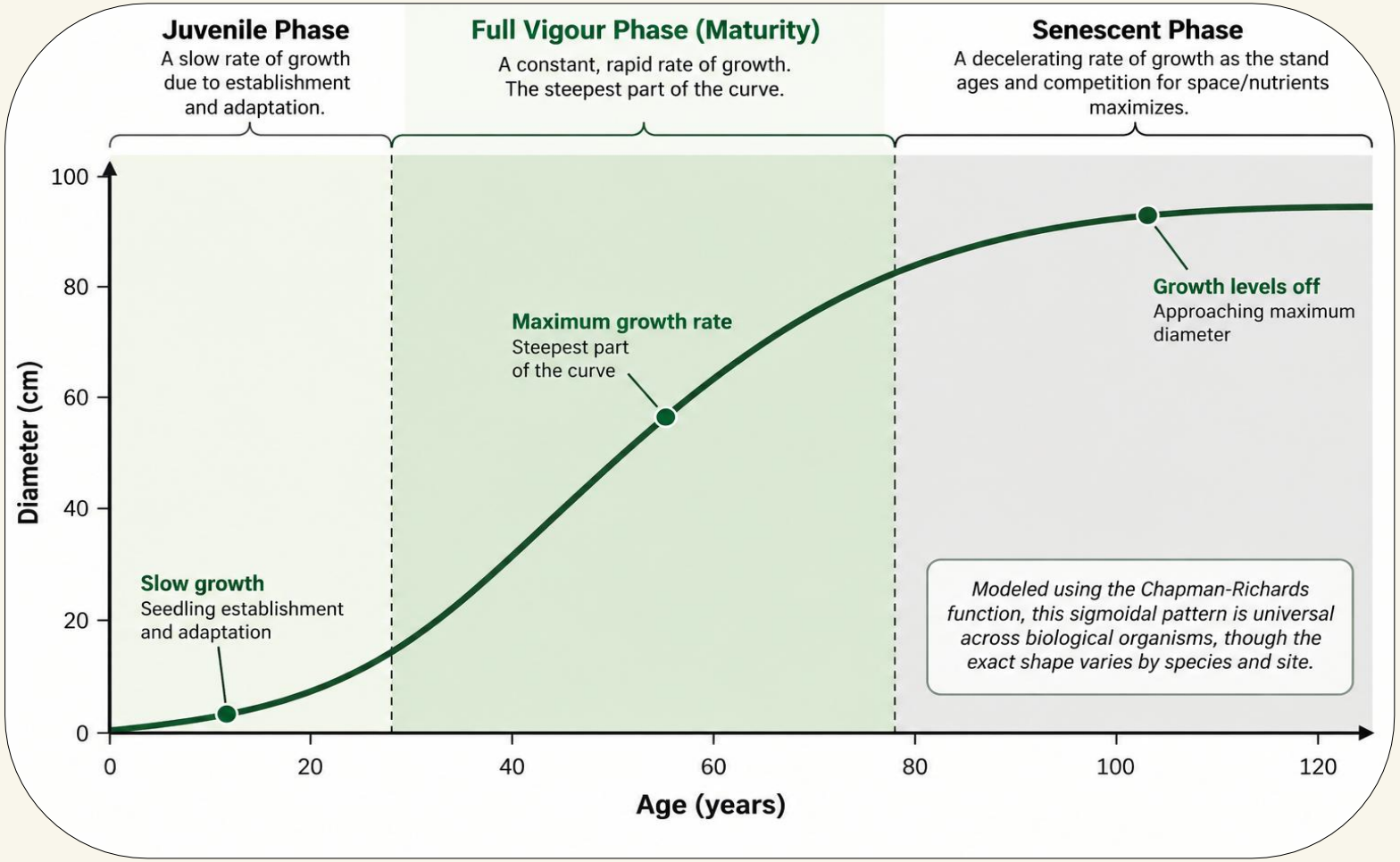
Stand size usually follows an S-shaped pattern.

Three stages

- Early stage: growth starts slowly.
- Middle stage: growth accelerates.
- Later stage: growth slows as the stand matures.

SIMPLE RULE

The slope of the curve shows how fast the stand is growing.



From Tree Size to Forest Productivity

A large stand is not automatically producing volume quickly.

Why measure increment?

- Tree size tells us how much has accumulated.
- Increment tells us how quickly new volume is added.
- Managers need the increment to evaluate productivity and timing.

MANAGEMENT USE

Measure the rate of change, not only the final tree size.



To measure the actual productivity of a forest, we must extract the rate of change from the growth curve. We must measure **Increment.**

Two Important Measures of Increment

CAI looks at one period. MAI looks at the long-term average.

CAI — Current Annual Increment

The volume added during one year.

Useful for tracking recent or short-term changes.

MAI — Mean Annual Increment

The average annual volume added since the stand began.

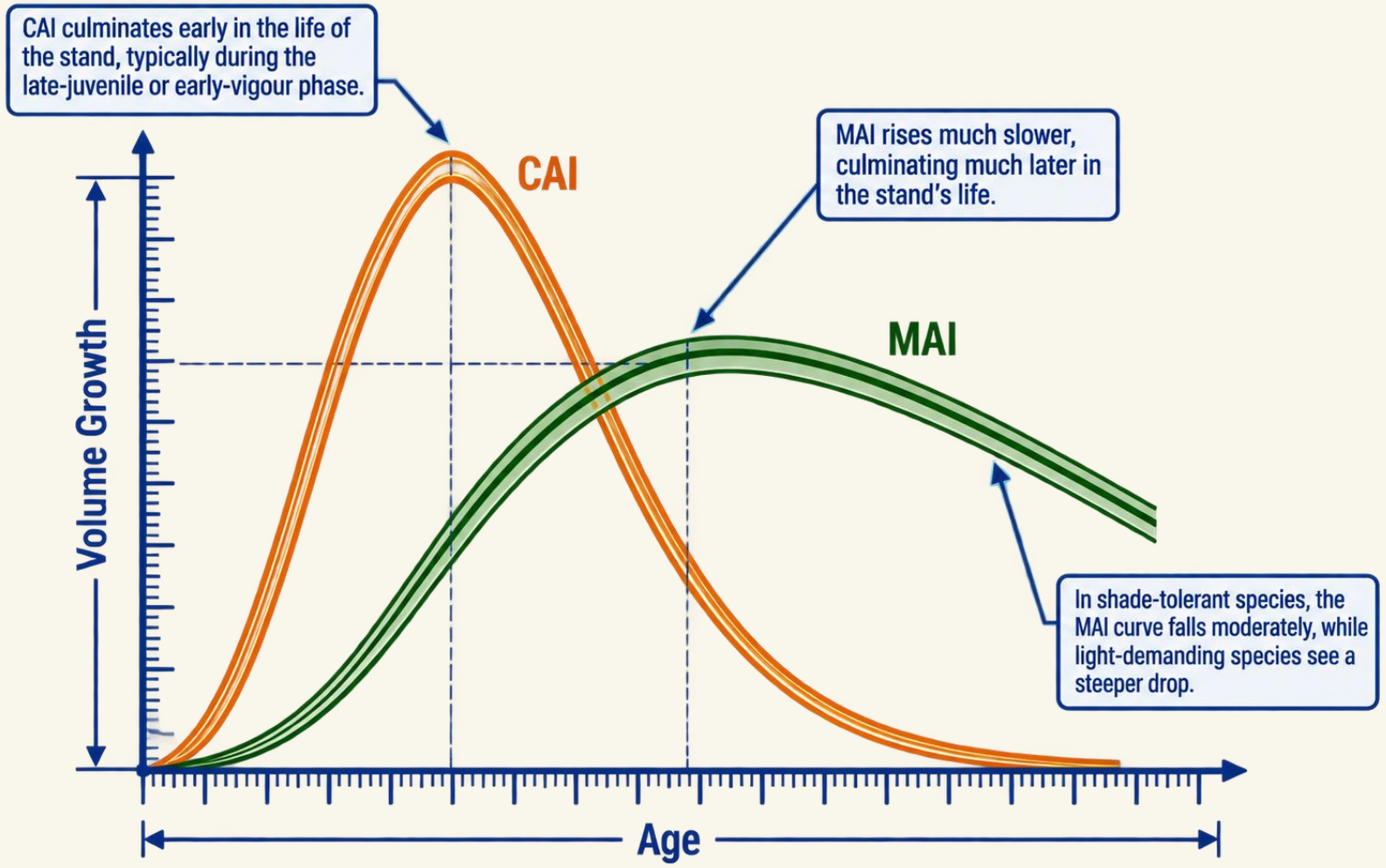
Useful for describing the stand's long-term productivity.

EASY MEMORY

CAI = this year. | MAI = average per year.

CAI and MAI Follow Different Patterns

The two curves help us understand stand productivity over time.



How to read the curves

- CAI can rise and fall quickly.
- MAI changes more slowly because it averages out fluctuations.
- The relationship between the two curves supports management decisions.

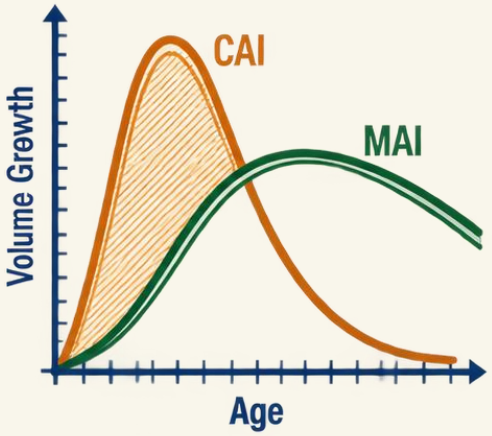
Three Simple Rules of Increment

These rules describe how CAI and MAI interact.

Remember

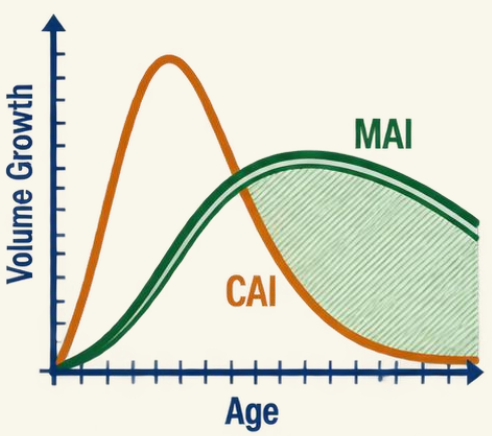
- When CAI is above MAI, MAI increases.
- When CAI is below MAI, MAI decreases.
- When CAI equals MAI, MAI is at its maximum.

Rule 1 (The Pull Up)



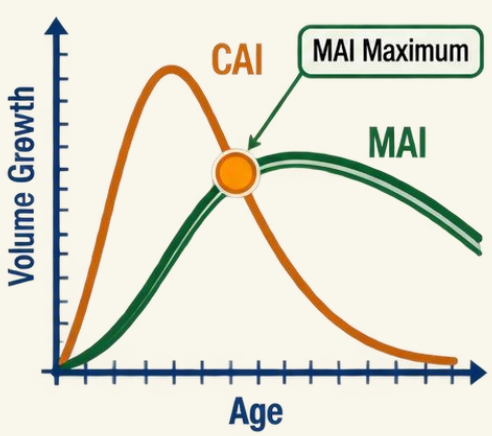
As long as CAI > MAI, the MAI curve must rise. Every new year of high growth pulls the historical average up.

Rule 2 (The Drag Down)



Once CAI < MAI, the MAI curve begins to fall. The current year's growth is no longer enough to sustain the historical average.

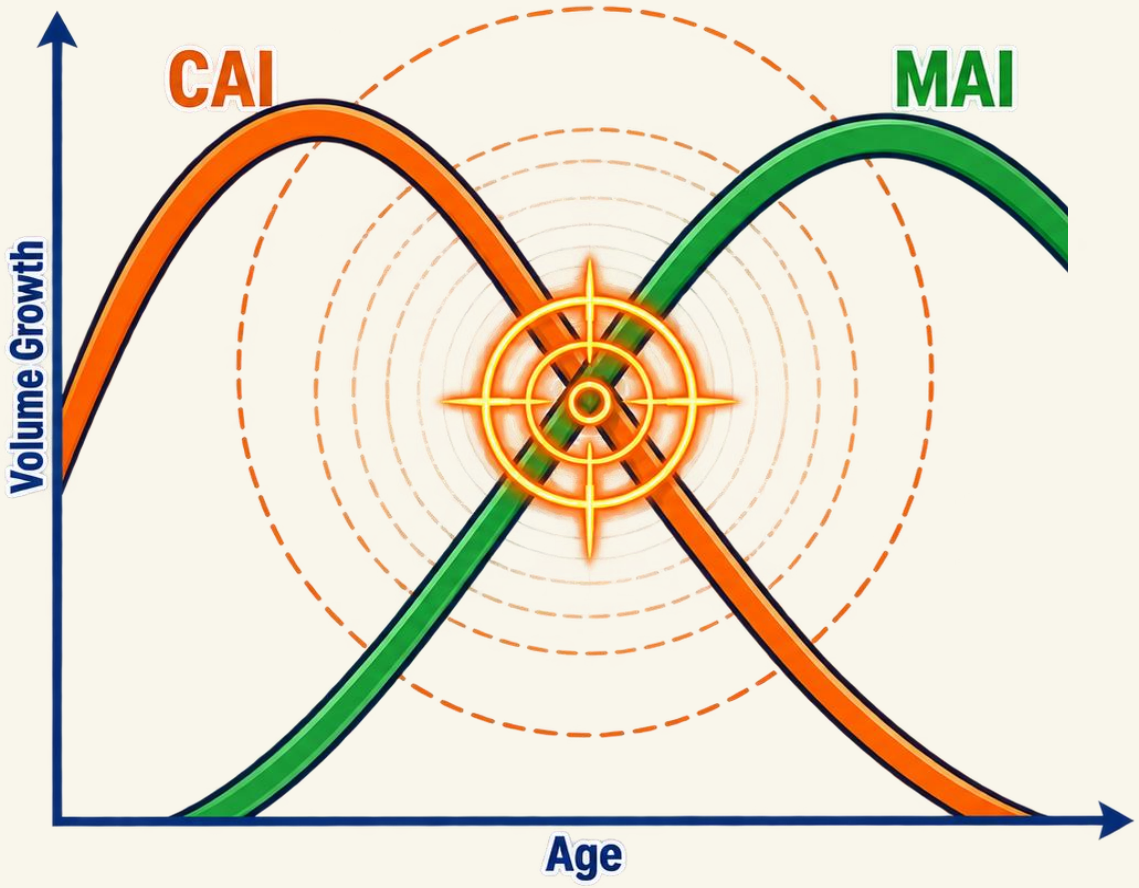
Rule 3 (The Zenith)



Therefore, MAI reaches its absolute maximum precisely at the point where the two curves intersect.

The Intersection: A Key Productivity Point

The point where CAI and MAI meet has practical meaning.



At the intersection

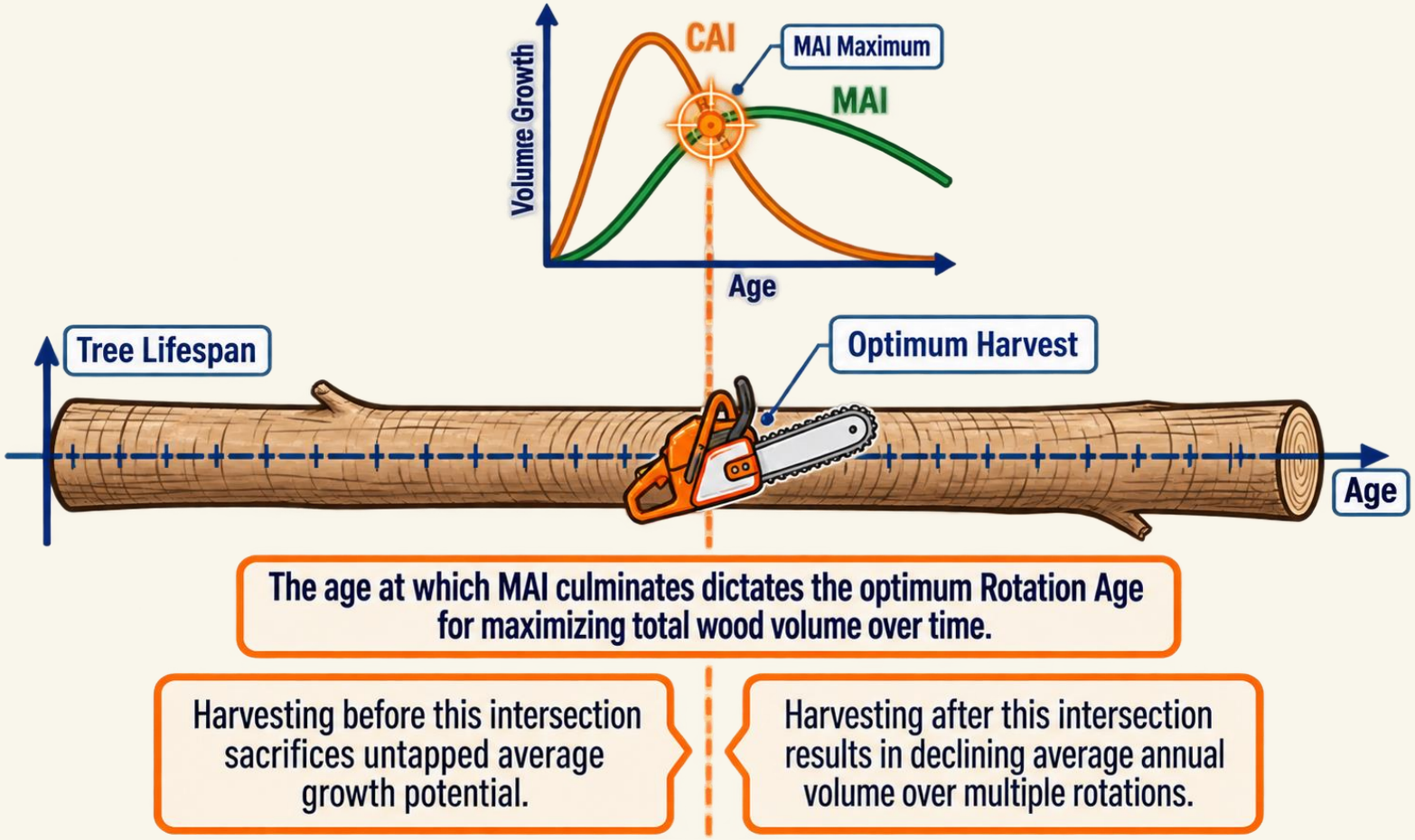
- CAI = MAI.
- MAI reaches its maximum volume production.
- The point can guide decisions about rotation age and productivity.
- That single point on the graph dictates two fundamental decisions in forest management

Application 1: Determining Rotation Age

Rotation age is linked to the point of maximum MAI.

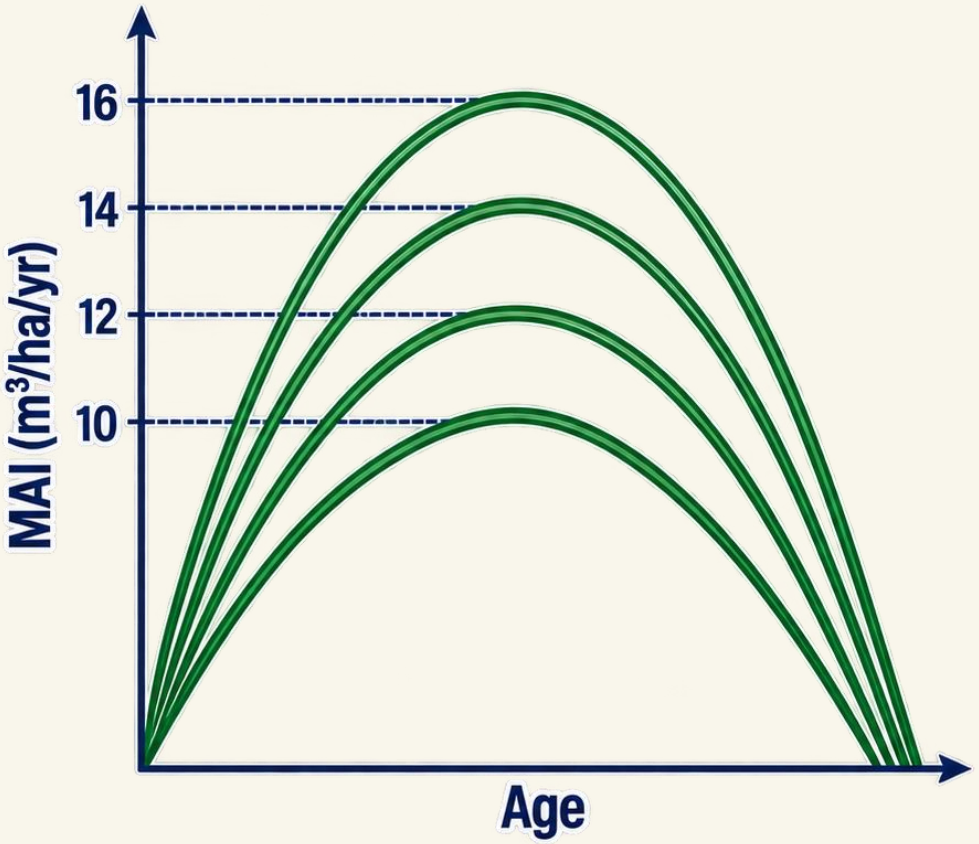
What does it mean?

- Harvesting before the intersection may sacrifice potential average production.
- Harvesting after the intersection may reduce average annual productivity.
- The final decision must also consider ecological, economic and operational goals.



Application 2: The Yield Class System

Yield class describes a site by its maximum MAI.



A site's overall growth potential is classified exclusively by its maximum MAI.

If a stand's MAI curve peaks at an average rate of **14 m³/ha/yr,** that site is officially designated as **Yield Class 14.**

The system simply splits the entire range of potential biological growth into standardized steps of **2 m³/ha/yr,** providing a universal language for site productivity.

How it works

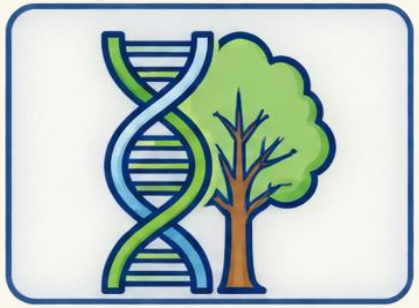
- A higher maximum MAI indicates greater site productivity.
- Yield classes group sites with similar productive potential.
- The system supports planning and site comparisons.

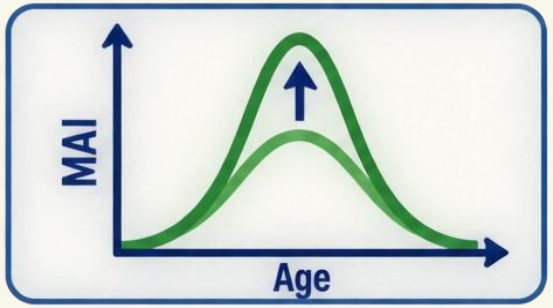
What Can Shift the Growth Curves?

Growth depends on both site conditions and forest management.

Main factors

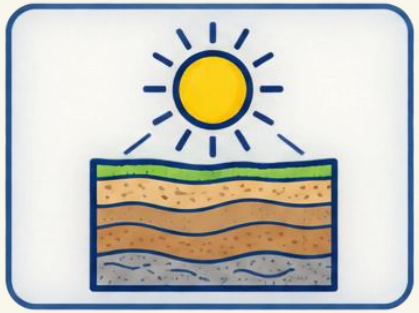
- Inherent site quality: soil, rainfall and water availability.
- Silvicultural practices: spacing, thinning and competition.
- Treatments and events: disturbance, fire, drought or other changes.

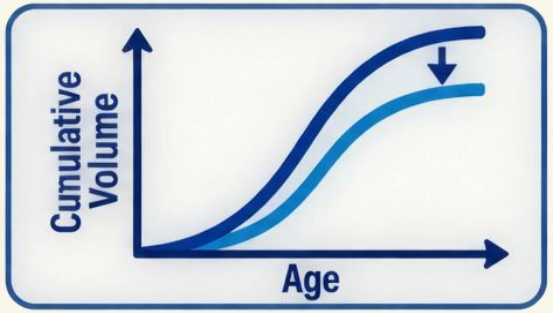




Inherent Site Conditions

Topography, soil fertility, and water depth alter how high the MAI curve can peak. A poor site creates a flattened curve; a fertile site creates a high peak.

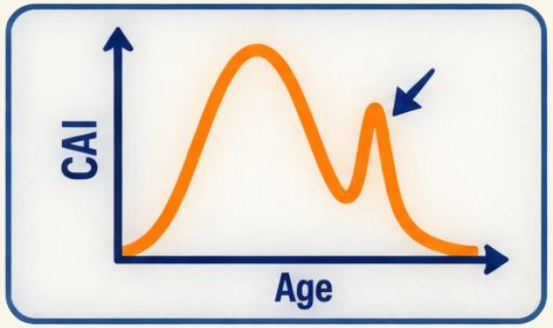




Silvicultural Spacing

Wider initial spacing reduces total cumulative volume (shifting curves downward) but accelerates individual tree diameter (DBH) growth.



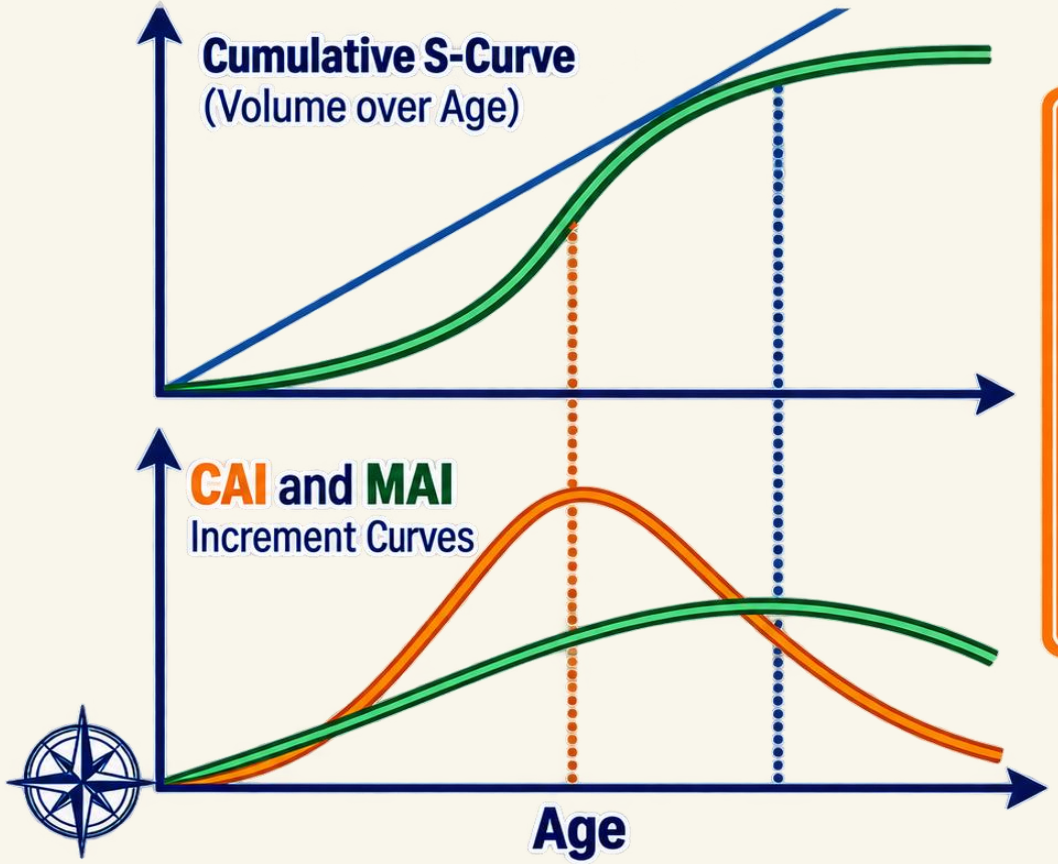


Treatments & Events

Thinning, fertilization, or environmental changes (like root systems hitting a buried fertile subsoil) can temporarily boost CAI, creating secondary spikes in the increment curve.

The Complete Productivity Blueprint

Use the curves together to interpret stand development.



The visual proof of forest mensuration.

The changing slope of physical size (top) perfectly dictates the mathematical rate of productivity (bottom).

Connect the ideas

- Cumulative growth shows total stand size.
- CAI shows the current rate of addition.
- MAI shows the average productivity over time.
- Together, they support forest planning.

Key Takeaways and Reflection

Check whether you can explain the main ideas in your own words.

Key takeaways

Growth is the total biological increase.

Increment is the amount or rate added over time.

CAI describes recent growth; MAI describes the average.

The CAI–MAI intersection marks maximum MAI.

Site conditions and management can change growth patterns.

Reflection questions

Why is a large tree not always evidence of high current productivity?

How are CAI and MAI different?

Why might a manager study the point where CAI and MAI meet?

QUICK CHECK

Explain CAI and MAI using one simple example from a forest stand.