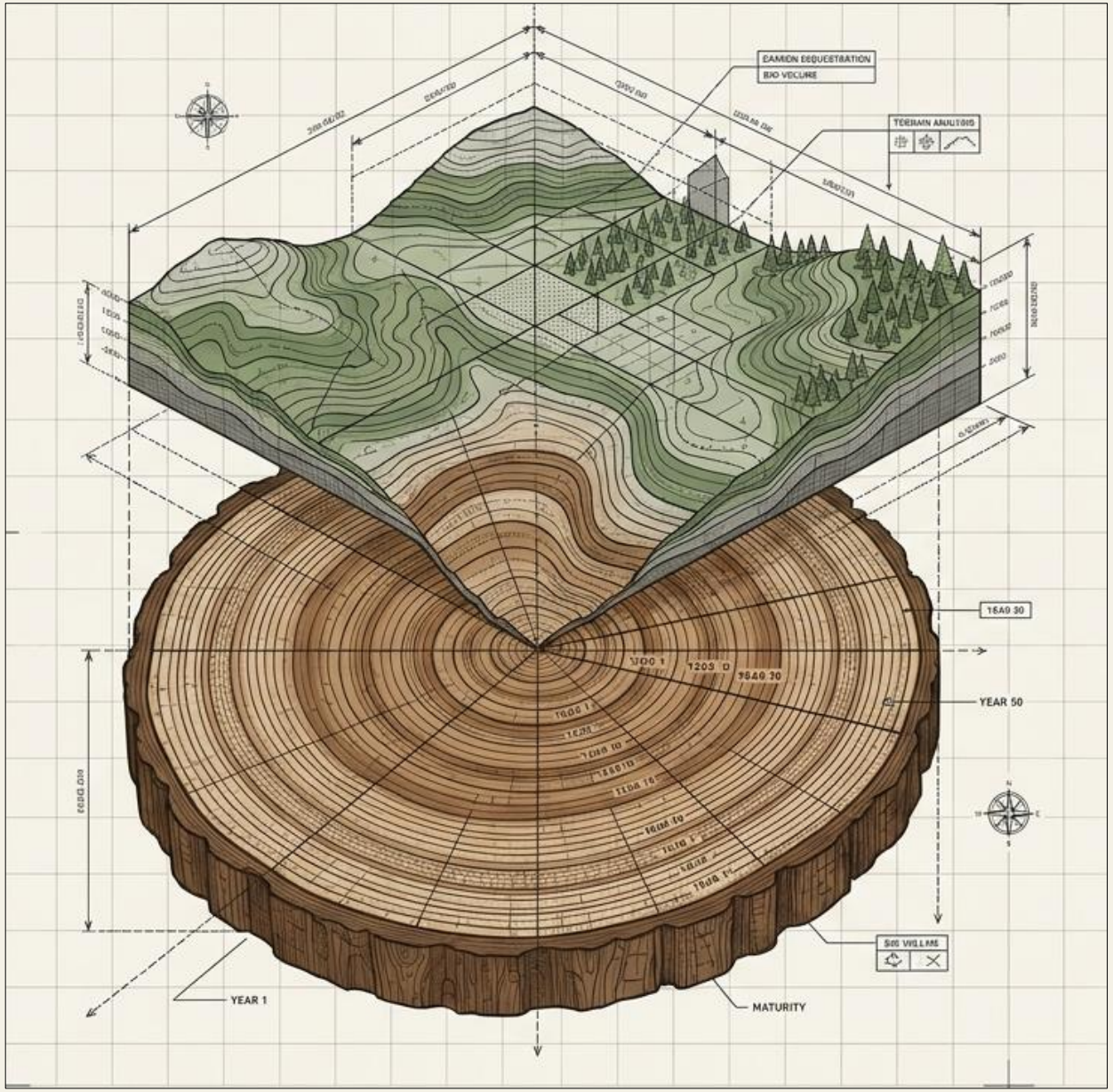
Optimum Yield & Sustainable Forest Management

From forest growth to practical harvest decisions

Understand how growth, economics and conservation shape sustainable harvest planning.

Micro-credential 3 • Module 3 • Topic 3



The Triad of Modern Forest Management

Three needs must work together

Production:

- Timber revenue, income and employment.

Environment:

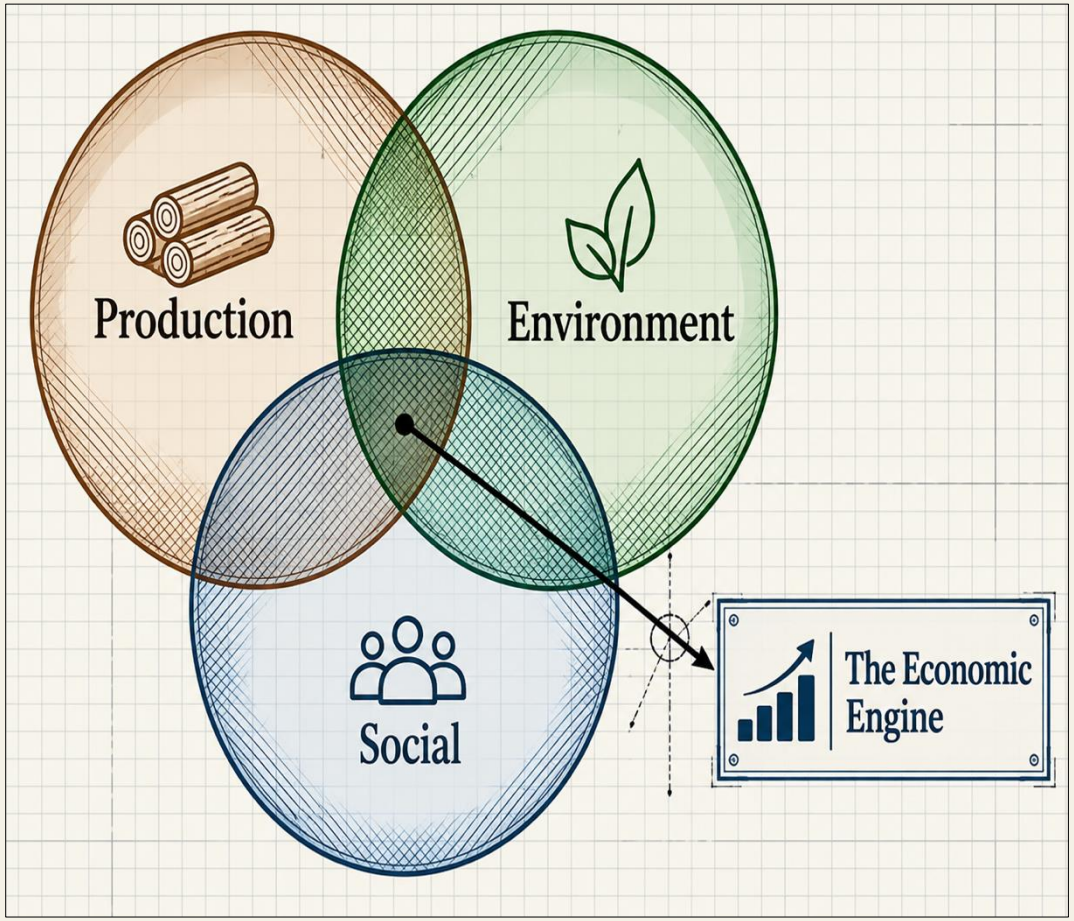
- Biodiversity, watershed protection, ecosystem services and carbon sequestration.

Society:

- Community participation, livelihoods and social values.

The economic Engine:

- Revenue earned from log harvesting typically funds long-term environmental management.



Planning Works at Three Levels

Connect national goals with field actions

Strategic/national:

- Long-term policy and direction.

Management unit:

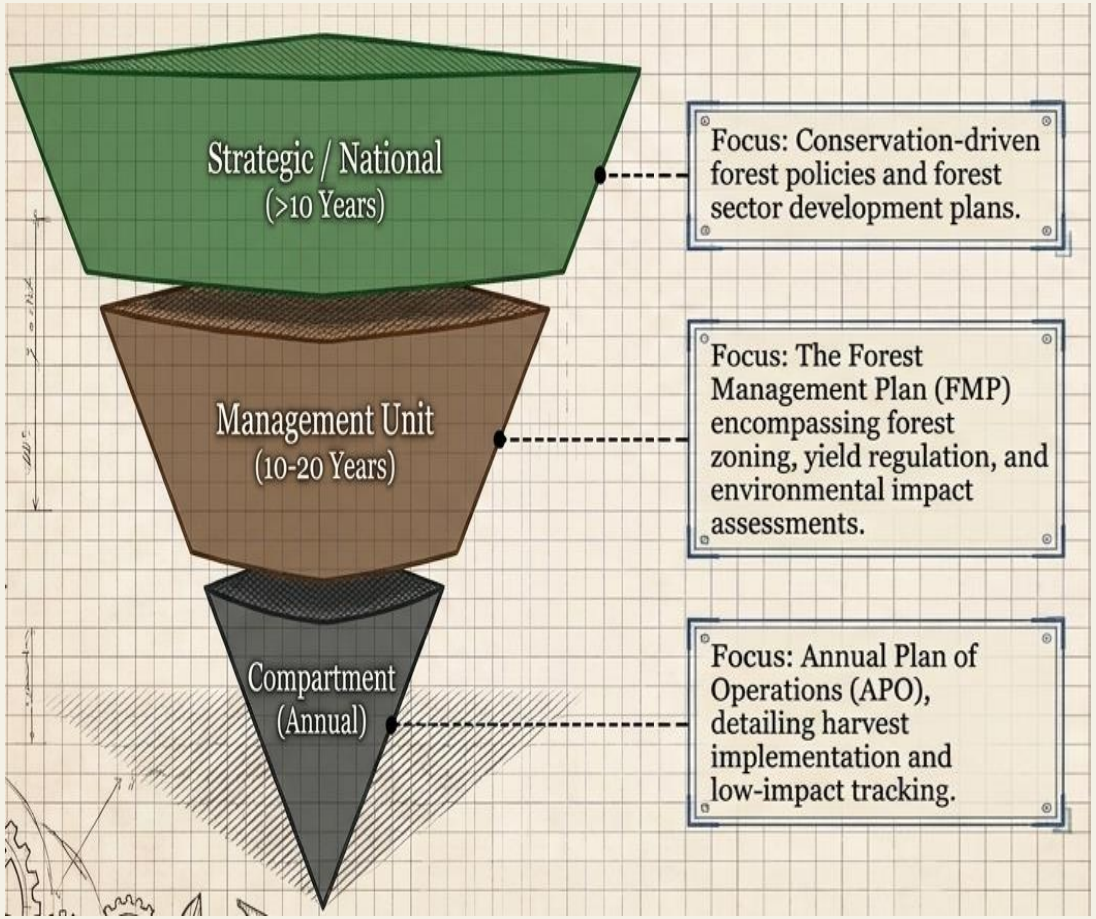
- Translate policy into forest management plans.

Compartment:

- Apply actions to specific areas and stands.

Minimum Duration:

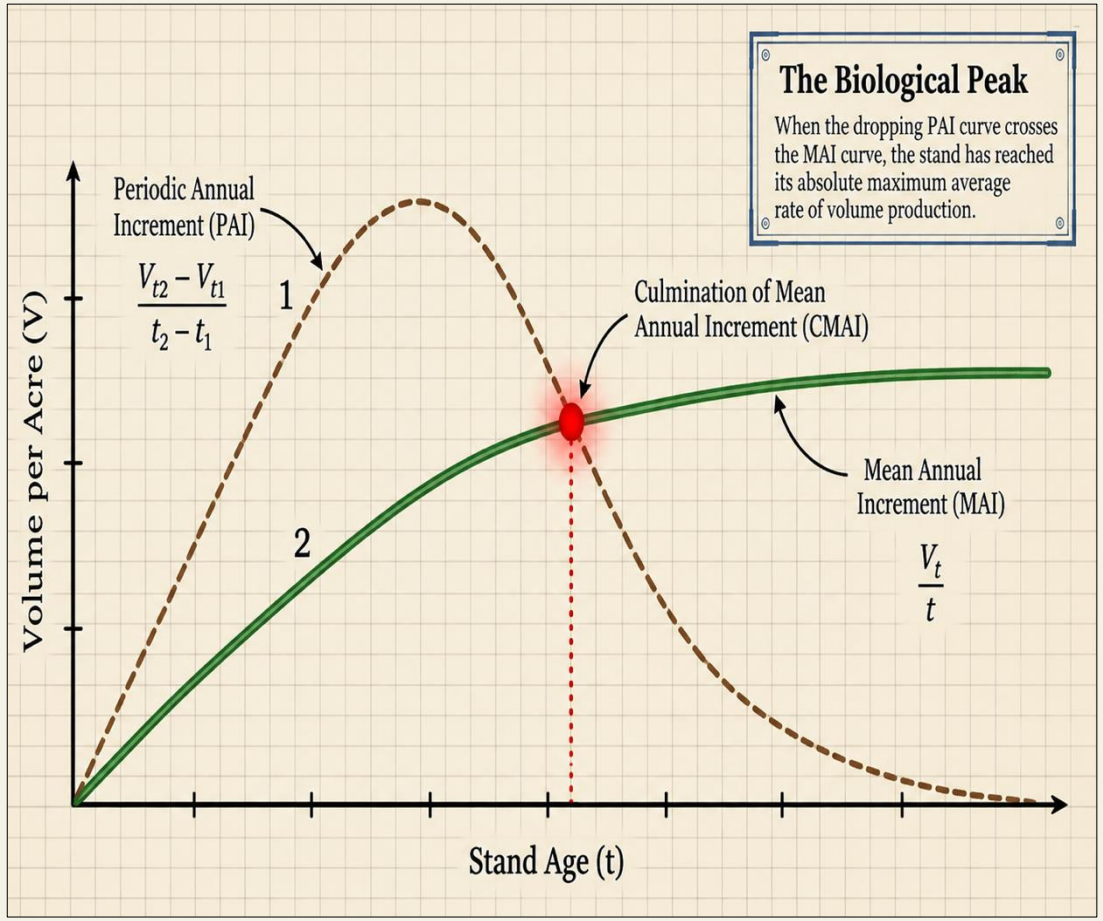
- A management plan must have a minimum 10-year duration to ensure medium-term stability. Shorter periods fail to guide consistent implementation.



Biological Growth Dynamics

A stand changes as it grows

- CAI = growth added during one year.
- MAI = average growth per year over the stand's life.
- The biological peak occurs where CAI and MAI meet.
- Use growth patterns to guide rotation decisions.

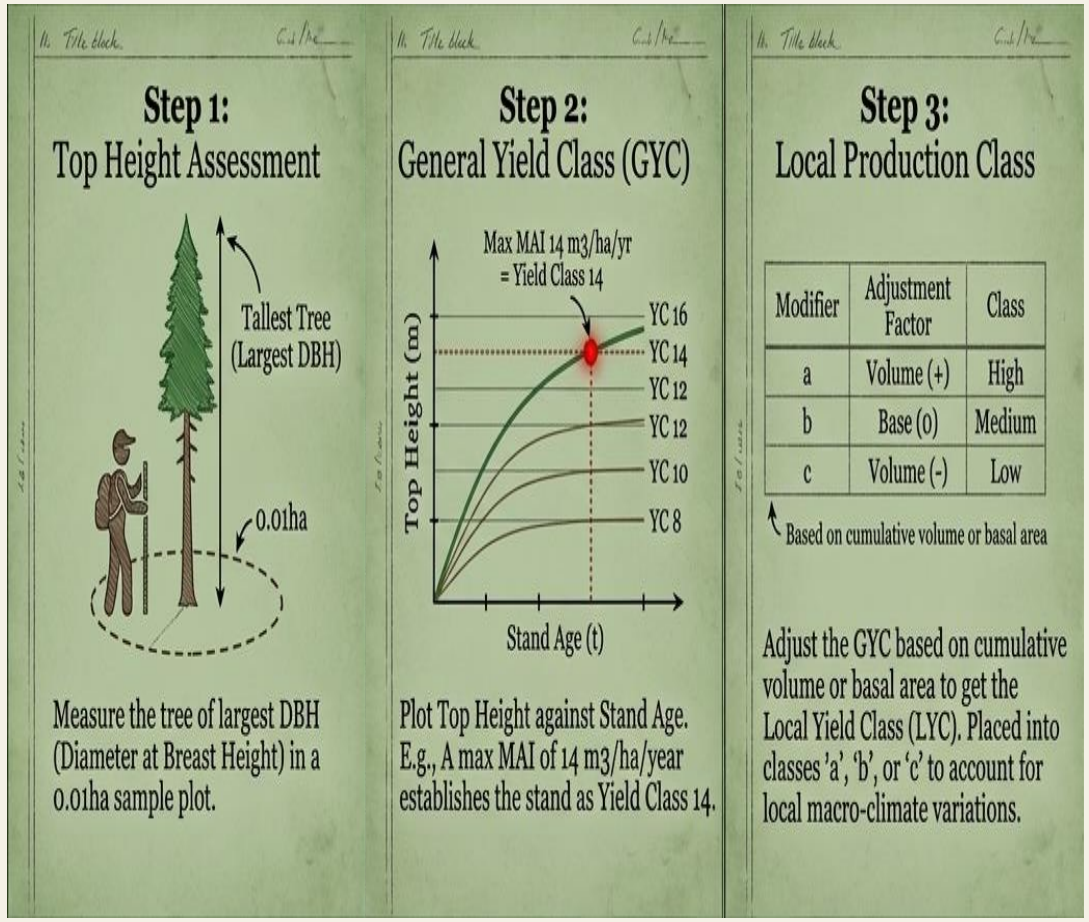


Key takeaway: Growth curves help explain when average production reaches its peak.

Predicting Growth: The Yield Class System

Estimate how productive a site can be

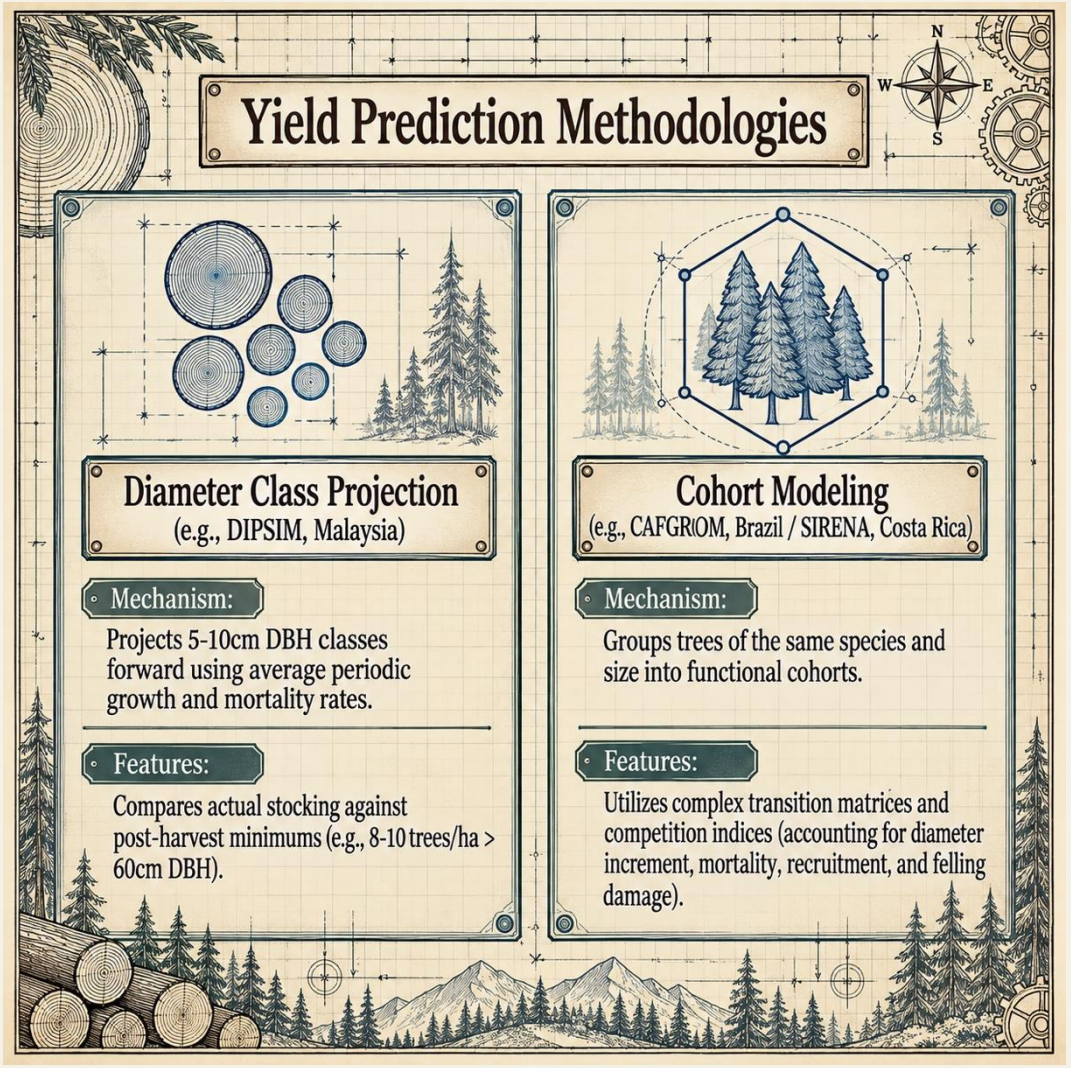
- Measure top height and stand age.
- Use the growth curve to identify yield class.
- Group stands with similar productivity.
- Yield class supports future harvest and management planning. It is an index of site potential, not merely a historical record of past volume.



Two Ways to Predict Yield

Choose a method that fits the information available

- **Diameter-class projection:** predict future diameter and volume by size class. This method is useful for preliminary analysis but ignores changes in spatial density and competition dynamics.
- **Cohort modelling:** follow groups of trees with similar age or size. Highly accurate and dynamic; the standard for modelling mixed, uneven-aged tropical forests.
- Both methods support longer-term growth forecasts.

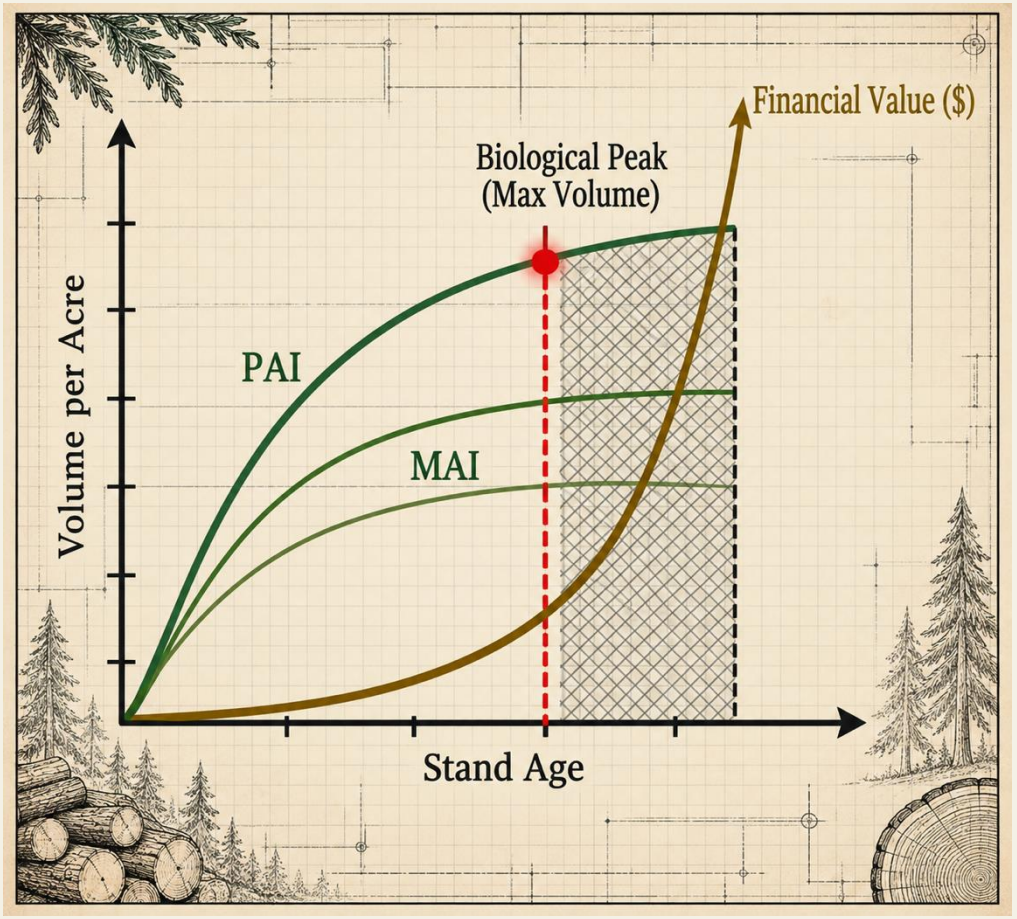


Harvest Decision I: Biological Rotation

Harvest timing is linked to growth

- MAI helps identify the age at which average volume production peaks.
- The biological rotation is not always the best financial rotation.
- A very late harvest may add little volume but increase waiting time.

The Product Class Jump: Maximising physical volume inherently ignores timber value. Waiting 1 extra year might drop the raw volume growth rate but allows trees to cross the critical diameter threshold from cheap "pulpwood" to highly lucrative "chip-n-saw" timber.



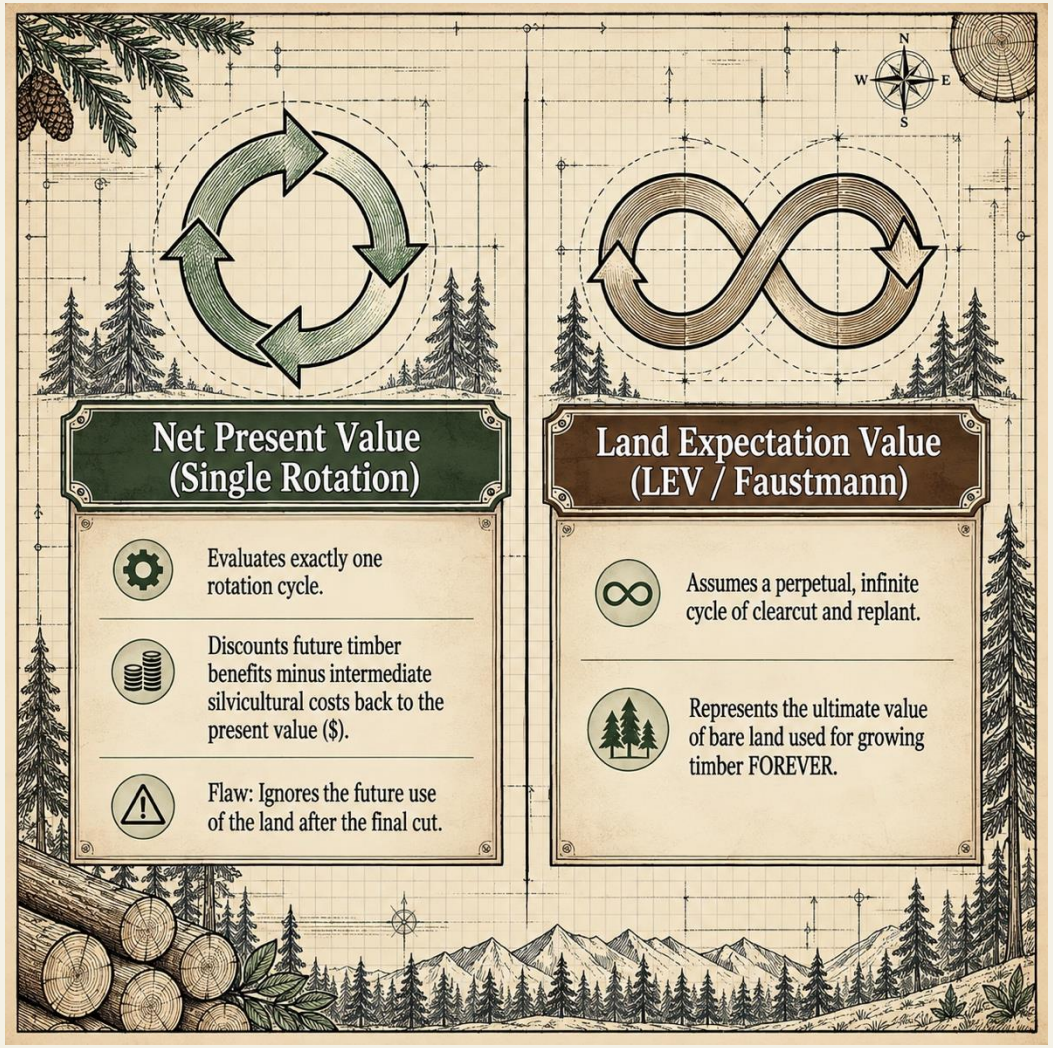
Key takeaway: Biological rotation and financial rotation may lead to different harvest ages.

Harvest Decision II: Economic Evaluation

Compare the value of different harvest timings

- Net Present Value (NPV): value received after discounting future costs and returns.
- Expected Value / LEV: compares land value over repeated rotations.
- Discounting means money received later is worth less today.

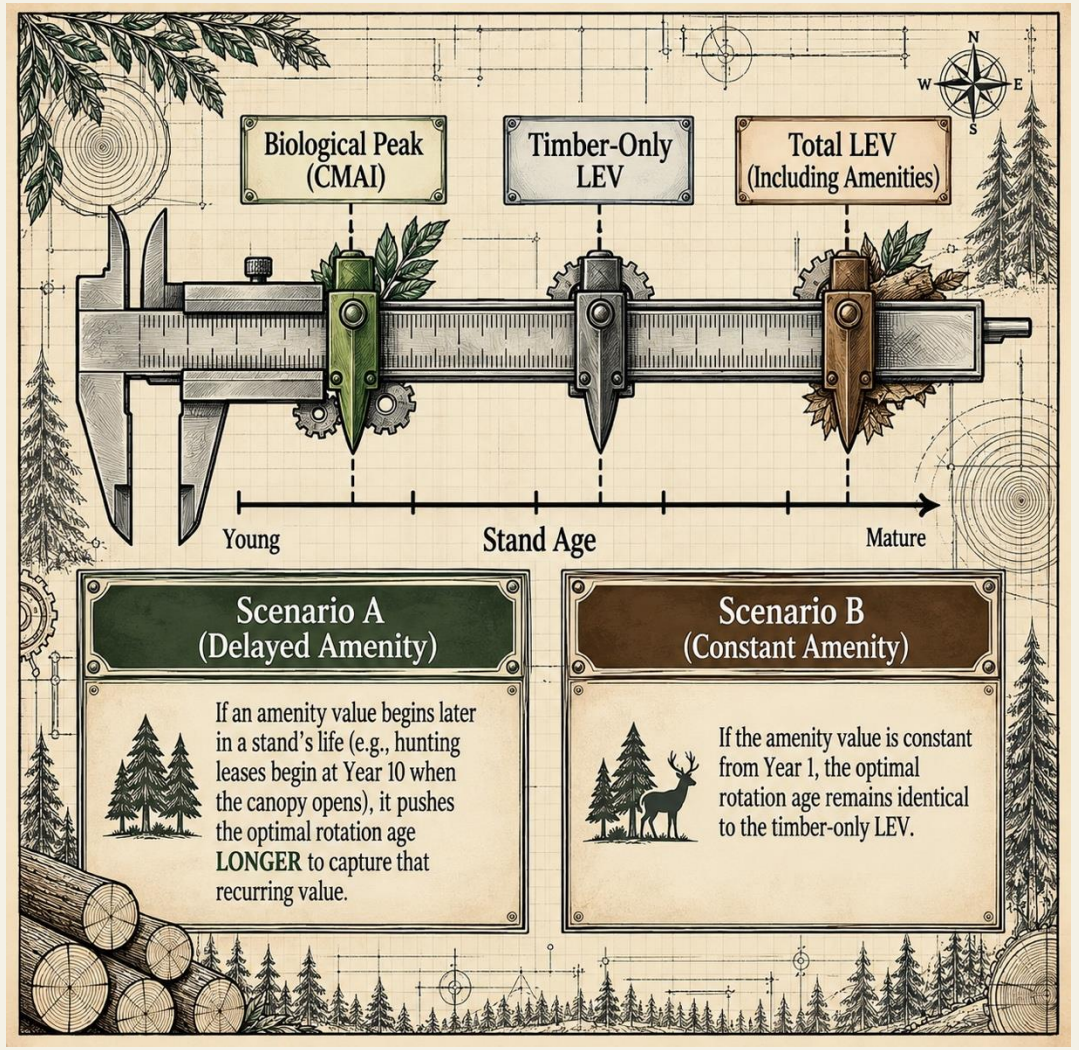
- The LEV model almost always results in a **SHORTER** optimal rotation age than the single-rotation NPV model because it mathematically accounts for the opportunity cost of delaying the next generation of trees.



Integrating Non-Timber Benefits into LEV

Forests provide more than timber

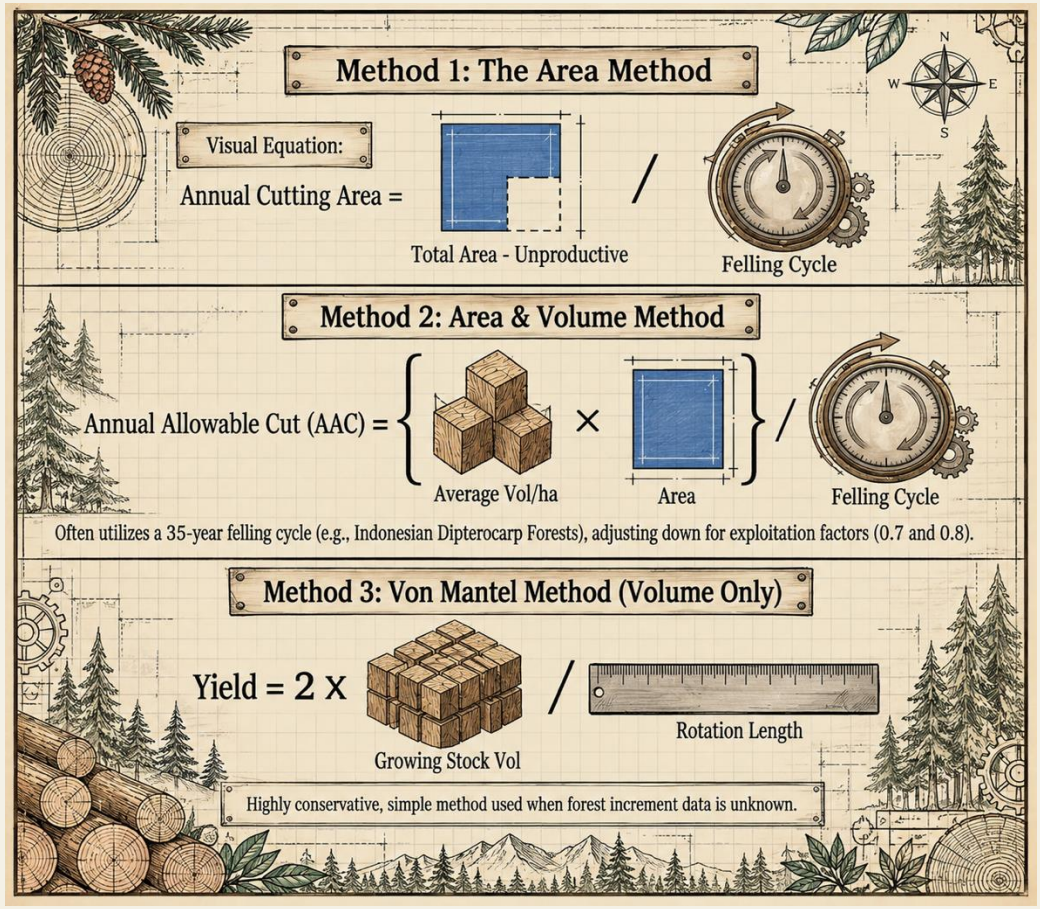
- Include recreation, water protection, biodiversity and carbon benefits when relevant.
- Compare timber-only value with total ecosystem value.
- A longer rotation may be justified when non-timber benefits increase over time.



Determining the Allowable Cut

Translate forest information into a harvest limit

- **Area method:** annual cut = forest area ÷ rotation length.
- **Area and volume method:** combine area, average volume and cutting cycle.
- **Volume-only method:** use standing stock and the planned rotation.
- Apply local constraints before confirming the final cut.

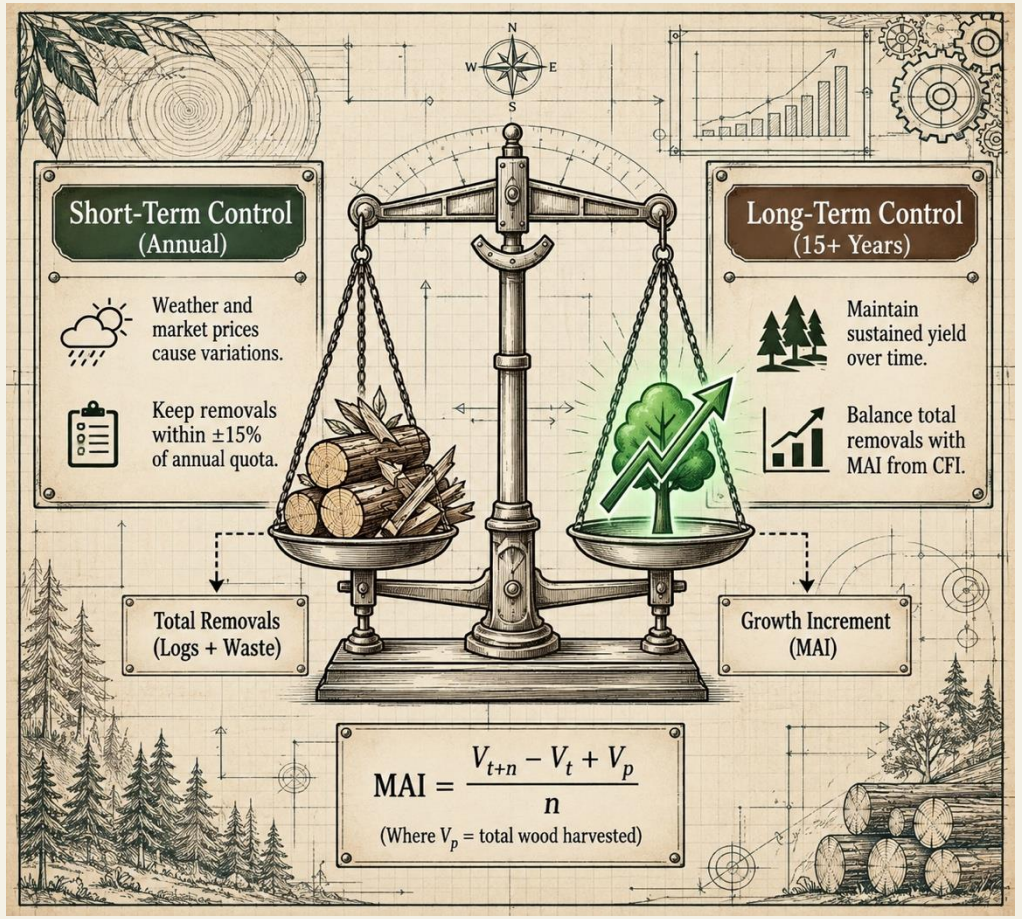


Key takeaway: An allowable cut must reflect both forest productivity and local constraints.

Regulating the Yield

Balance harvest removals with forest growth

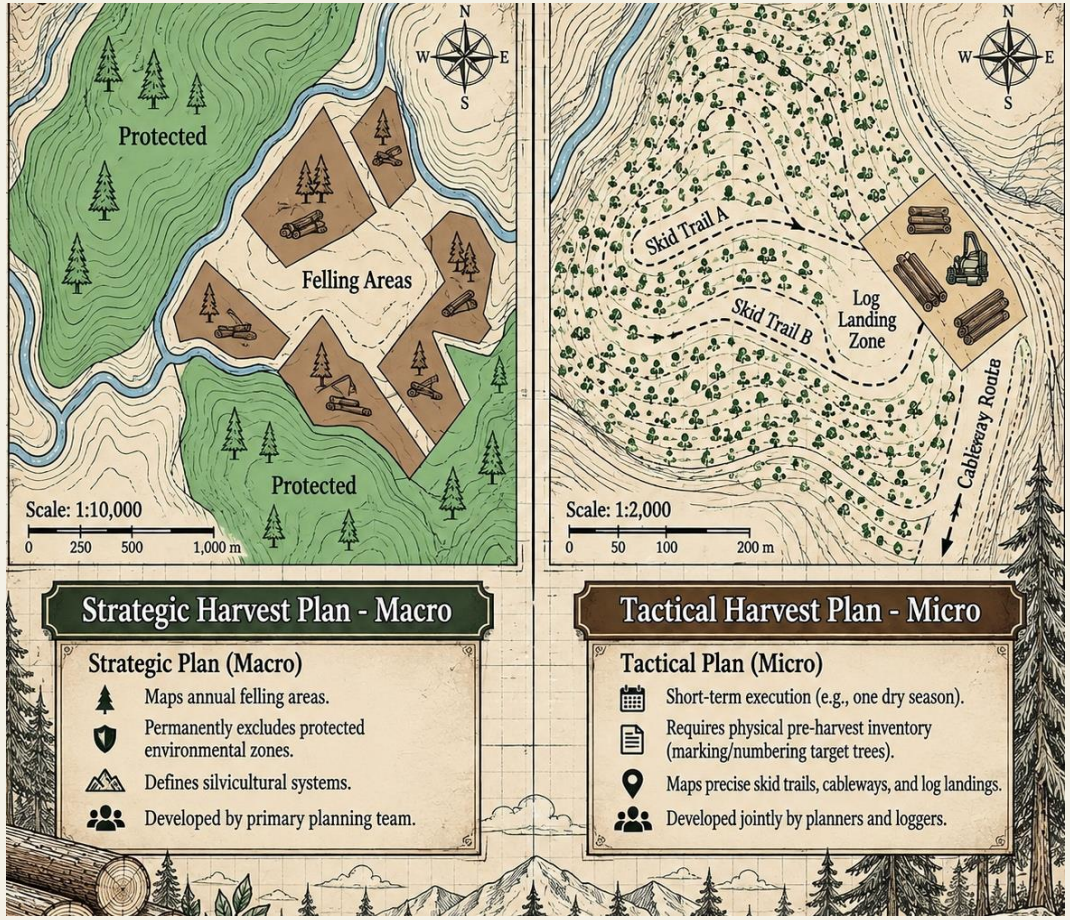
- **Short-term control (annual)** responds to current prices, costs and operating conditions.
- **Long-term control (>15 years)** aims to keep harvest within sustainable growth limits.
- The goal is to avoid removing more than the forest can replace over time.



Harvest Planning: Macro to Micro

Plan broadly, then act precisely

- **Macro plan (Strategic harvesting):** protected areas, harvest zones and strategic access.
- **Micro plan (Tactical harvesting):** individual compartments, roads, coupes and operational details.
- Use maps and field checks together before harvesting.



The Golden Rule of Sustainable Forestry

Keep harvest within the forest's ability to recover

- Compare the accumulated mean annual increment with the total harvest.
- Over a suitable planning period, growth should meet or exceed removals.
- Restoration is needed when forest condition falls below the desired level.

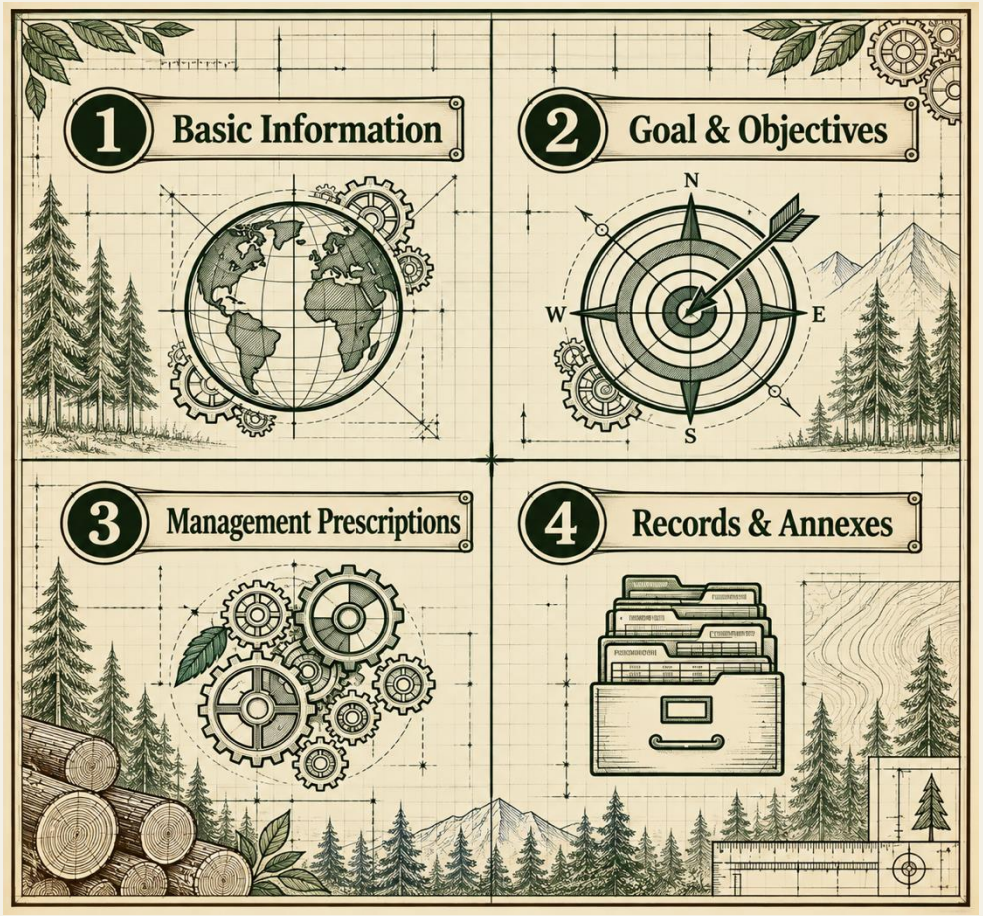


Key takeaway: Sustainable forestry requires harvest removals to remain within long-term growth.

The Four-Part Forest Management Plan

A complete plan needs four linked components

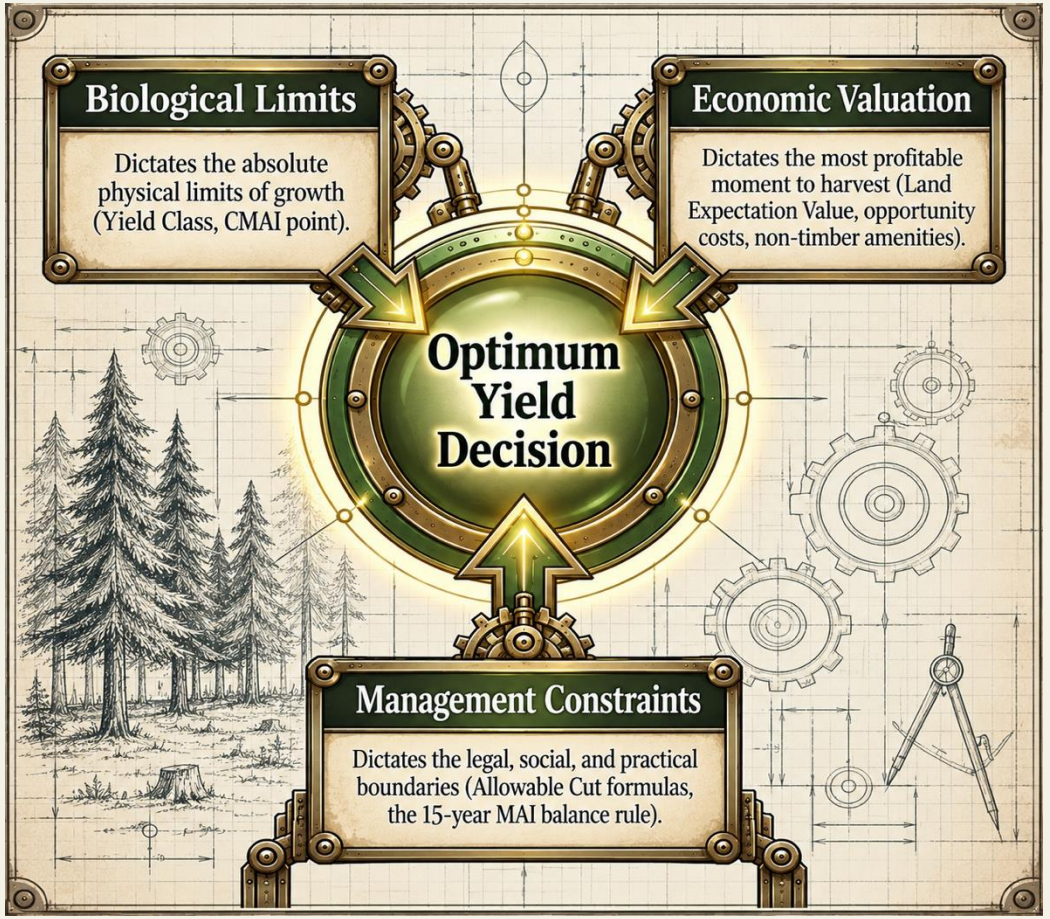
- **Basic information:** Forest condition, physical resources, location & environmental constraints.
- **Goals and objectives:** Desired outcomes and management priorities.
- **Management prescriptions:** Actions, timing and operating rules (e.g., zoning, silvicultural, harvesting, accountability metrics).
- **Records and annexes:** Maps (GIS), forest inventories, monitoring data and supporting documents.



Lecture Synthesis: The Optimum Yield Matrix

Make harvest decisions using four questions

- **Biological limits:** What can the forest produce?
- **Economic valuation:** What are the costs and benefits?
- **Management constraints:** What must be protected or retained?
- **Social and policy context:** What outcomes are expected?
- Optimum yield is a balanced decision, not a single number.



Key takeaway: Use biological, economic, management and social information together.