

The role of Models in answering questions of Forest Sustainability

Robert A. Monserud

RMRS & PNW Research Stations

Portland, Oregon, USA

Presented at the:

Forest Modelling for Ecosystem Management,
Forest Certification, and Sustainable
Management Conference

August 17, 2001

Vancouver, BC, Canada

Caveats

- Impossible to validate any model (Popper 1963).
- All models are false, but some models are useful. Our job is to identify the useful ones (G.E.P. Box).
- No model can be evaluated in the absence of some clearly stated objective (Goulding 1979).
- No criterion is universal, so some subjectivity must always remain.
- Empiricism cannot be avoided, and keeps models grounded in reality.

Sustainability:

New Management Considerations

- *Overriding concern: public acceptance of forestry*
- Phasing out of clear cuts
- Moving to spatially heterogeneous structure
 - Variable retention or Green-tree retention
 - Variable thinning
- Mixed-species, Multiple ages, Legacy retention
- Riparian buffers
- We lack growth models and long-term data to determine if Variable Retention is sustainable

Classes of forest models

- Forest Growth and Yield models
- Ecological Models
 - Gap models (Population Succession)
 - Compartment models (Resource Fluxes)
- Process/mechanistic models
- Hybrid models

Forestry growth models

(e.g., CACTOS, FPS, FVS, ORGANON, SPS)

- Goal: site-specific *prediction* of yield over time
- All have site calibration, basic silviculture, variety of sample designs, wood products
- Few have regeneration
- Uncertainty sometimes modeled
- No link to underlying causes of productivity:
 - Carbon and Nutrient cycles
 - Climate
 - Moisture regime

Ecological Succession Models

(JABOWA / FORET tradition)

- Goal: Test ecological population theory
- Intentionally not site specific, but Zelig-pnw requires many soil & climate parameters
- No typical forestry inputs or outputs
- Uncertainty not modeled (deterministic)
- Difficult to verify long-term succession
- SORTIE-BC is a promising alternative
 - Plot size is NOT a growth parameter
 - Wide range of forest management options

Process models

(e.g., PnET, PipeStem, ECOPHYS, FOREST-BGC)

- Goal: Scientific explanation, not prediction
- Model of key growth process(es) and underlying causes of productivity:
 - Photosynthesis, respiration
 - » (Carbon allocation)
 - Nutrient cycles
 - Climate
 - Moisture regime, water stress

Problem: Predicting if forest management is sustainable

- Forest G&Y models not based on the underlying causes of productivity or fundamental processes of growth.
- Ecological models not connected to forest management needs, with *ad hoc* elements.
 - Suffer from inbreeding
- Process models based on some of the fundamental aspects of growth and productivity, but difficult to demonstrate accurate stand development
 - But see work by Mäkelä for Finland, and
 - Landsberg & Waring (3-PG)

Hybrid Models:

A process model for the manager

- PipeQual/CROBAS: Mäkelä for Finland
 - Carbon balance
- 3-PG: Landsberg & Waring
 - Light, water balance
- Ågren for Sweden
 - Soil carbon cycling (spp. substitution)
- FOREST 5: Robinson
 - Elements of CROBAS, PnET, LINKAGES

Mäkelä et al. (2000 *Tree Phys.*)

- Key factors affecting acceptance & usage of process/hybrid models:
 - Credible science
 - Understandable documentation & coding
 - Completeness (e.g., regeneration, weather, disturbance, uncertainty)
 - Ease of calibration & evaluation
 - Demonstrations of utility to managers

Future Needs (Ideal)

- Elucidation of a complete scientific theory of tree growth, stand dynamics, and forest productivity.
- But avoid “Battle of the Models” pitfall (Rogers 1998):
 - It does not follow that the Best Possible Model will serve the manager’s needs, or will even be implemented.
- Avoid “Strategy of Hope” pitfall:
 - Hope that someone, somewhere, someday will use your model for something useful.
 - Work with managers & give them what they need.

Future Needs (somewhat practical)

- A modeling paradigm that is:
 - Based on the fundamental causes of productivity and growth
 - Formulated for the forest manager's needs
 - » Facilitates management decisions
 - Uncertainty is reasonably represented
 - Verifiable to reasonable accuracy
 - Capable of being falsified
 - Capable of predicting novel, emergent properties
 - Transparent, Portable, and Adaptable for other scientists and regions