Evolving MYRLIN for sustainable management of Mixed Tropical Forests in the 2020s

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by

Denis Alder

Consultant in Forest Biometrics
What is MYRLIN?

MYRLIN is an acronym for Methods of Yield Regulation with Limited Information.

It was originally developed under a UK-DFID project at the University of Oxford 1999-2002.

It comprises three linked tools for assisting forest managers to plan sustained yields from naturally-regenerated mixed species and age class tropical forests (MTF).

These modules were:

- A forest inventory module to calculate and summarise stand tables in a format suitable for growth projection.

- A calibration tool for growth rates for ecological and functional species groups, based on general principles relating mature size and ecological guild to growth and mortality rates.

- A concession-management growth model, that calculated allowable cut and felled areas by years using a stand projection model linked to the outputs from the above two modules.

Since the completion of the project in 2002, there has been a steady demand for the use of MYRLIN by SMEs around the world. It has been adopted for teaching at several universities.
Original 3 Excel modules of Myrlin

#1 Stand table compilation module

#2 Growth estimation tool

#3 Harvesting model

Management assumptions

Inventory plot or stock survey data

Species ecology, wood density, mature size

AAC estimates
Key design concepts – stand model

- Accessible and simple, originally coded in VBA
- Conventional stand projection by diameter classes
- Requires average growth rates and mortality rates
- Recruitment based on equilibrium assumption (recruits = losses + removals)
Concession management with MYRLIN

The context of felling cycle, annual coupe, and areas required for regrowth and recovery often ignored.

Myrlin concession model allows actual block/compartment data and stocking to be read from inventory.

Areas required for a given level of yield then calculated, considering heterogeneity of forest.

Actual felling plan produced.

Can work from simplified data (no subdivisions, homogeneous stand table).

1. Zoning
Ecological and management zones

2. Management inventory
Felling units and coupé planning

3. Stock mapping:
Sub-coupe mapping of trees and harvesting trails
Pan-tropical growth rate comparisons

A central element of MYRLIN project is the observation that MTF species growth rates fall into typical patterns based on mature tree size and ecological guild.

Data from tropical forests in Papua New Guinea, Guyana, Brazil, and Costa Rica show similar patterns.
Pan-tropical models

A method was developed to calibrate species growth rates based on observations of maximum size, from inventory data, probable ecology, and wood density, which allowed for variation in site productivity between regions.

- **A, B** – Small persistent understorey trees
- **C, F** – Small trees growing in gaps, light demanding
- **G, H** – Pioneers, very light demanding, fast growth
- **E, J, K** – Typical mid-size trees, narrow crowns just in canopy,
- **D** – High density, shade tolerant smaller trees of upper understorey
- **M, N** – Slow growing, denser main canopy trees
- **S** – Dense, slow growing long lived emergent
- **L** – Faster growing, light demanding of main canopy
- **P, S** – Fast growing gap opportunist, light demanding, becoming canopy emergent.
This study also showed that average annual mortality rates (AMR) could be correlated with mature size and growth rate.

Small, fast growing species tend to have high mortality rates.

Large, slow growing species have low mortality rates.

X-axis shows actual species mortality.

Y-axis shows mortality estimated as:

$$\text{AMR} = 1 - 0.05^{\frac{\text{D}_{\text{inc}}}{\text{D}_{95}}}$$

Coefficient of Determination ($R^2$) is 70%

Regression overestimates true mortality, but this can be corrected.

Reference:
Alder, D; Oavika, F; Sanchez, M; Silva, JNM; Van der Hout, P; Wright, HL. (2002)
A comparison of species growth rates from four moist tropical forest regions using increment-size ordination. 
*International Forestry Review* 4(3) 196-205
Evolution with FAO

- Conversion from Excel-based to R app
- Library of models
- Improvement of growth modelling method
- Integrated with Open Foris Collect/Calc/Arena
- Test cases and field application
- User documentation/workshops
Library/database of models

- Original database covered 4 regions (Amazonia, Guyana, Costa Rica, Papua New Guinea), 411 PSPs, as shown in the table

- Additional data available for Ghana PSPs.

- Extended measurements from Brazil (to 2011) and new PNG data to 2010.

- To be organized into a library of models by biomes, guild, and genera/species

- Provided and documented as PostgreSQL tables

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Model enhancements

- Re-written in R for compatibility with current FAO systems (Open Foris Collect/Calc and Arena).
- Model repository as PostgresQL tables, for same reason.
- Modelling algorithm re-written in cohort form instead of diameter class projection
  - More accurate, flexible, fewer assumptions
  - Incorporation of differential mortality rates for damaged/understorey and sound/canopy trees
  - Data already available from regional models (PINFORM, CAFOGROM etc)
- Logging damage modelled based on recent research, generally showing exponential mortality decline over 20 years after logging.
  - More accurate, realistic
  - Mitigates against short-cycle and high-intensity logging regimes
Cohort vs. Diameter Class models for mixed tropical forest

Cohort

- N. Queensland
  - Vanclay (1989)
- CAFOGROM
  - Brazil 1994-2011
- SIRENA
  - Costa Rica 1996
- PINFORM
  - PNG 1998
- GEMFORM
  - Guyana 2002-2007

Diameter class

- Historical
  - e.g. Brandeis (1890s)
- GHAFOSIM
  - Ghana, 1989
- IWOPLAN
  - 2001
- MYRLIN
  - 2002

Stand models, complex representation of stand dynamics

Simplified models needed – complexity a constraint
Cohort vs Diameter Class
Guyana Greenheart data over 36 years

- Original, 1964
- Observed, 2000
- Predicted, DC model
- Predicted, Cohort model
Conclusion

- Current work will provide (by January 2020):
  - Database of models, both original and updated for Brazil and PNG, new data for Ghana
  - R algorithms and core engine for cohort model version of MYRLIN
  - Documentation of database and algorithms
- To be integrated with and support implementation of new version of MYRLIN within ARENA