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

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by

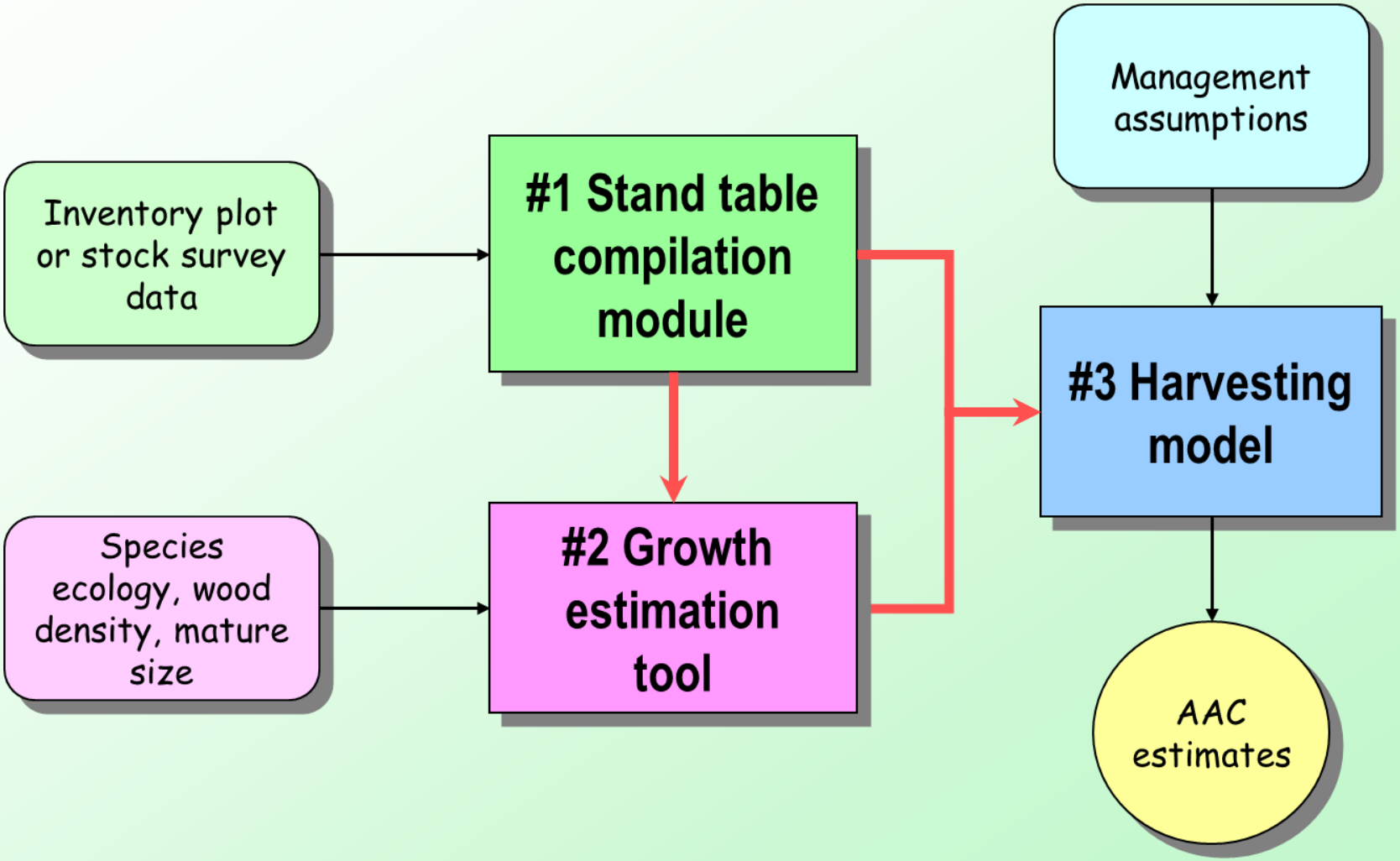
Denis Alder

Consultant in Forest Biometrics

What is MYRLIN?

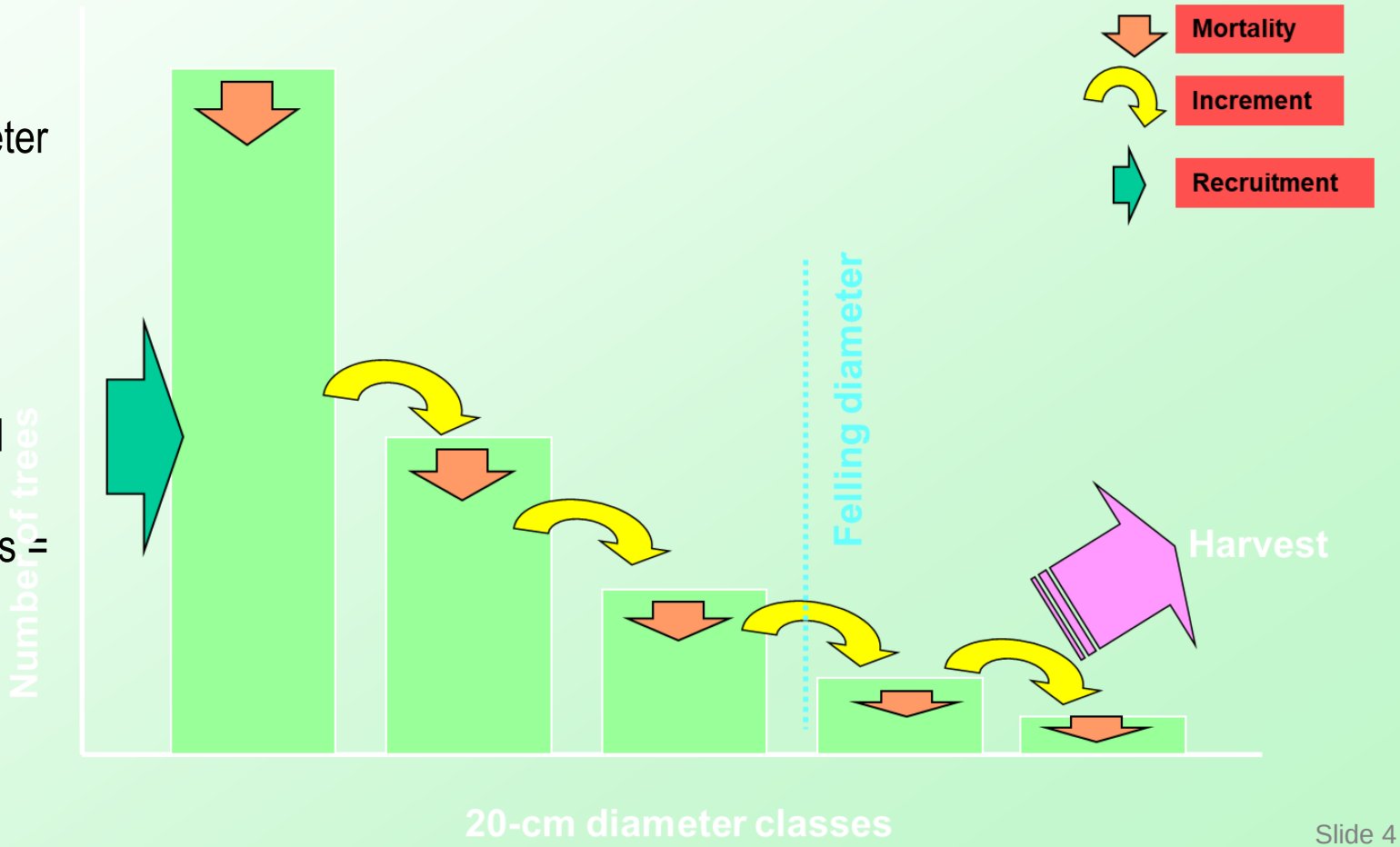
- MYRLIN is an acronym for Methods of Yield Regulation with Limited Information.
- It was originally developed under a UK-DFID project at the University of Oxford 1999-2002.
- It comprises three linked tools for assisting forest managers to plan sustained yields from naturally-regenerated mixed species 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 form 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



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)



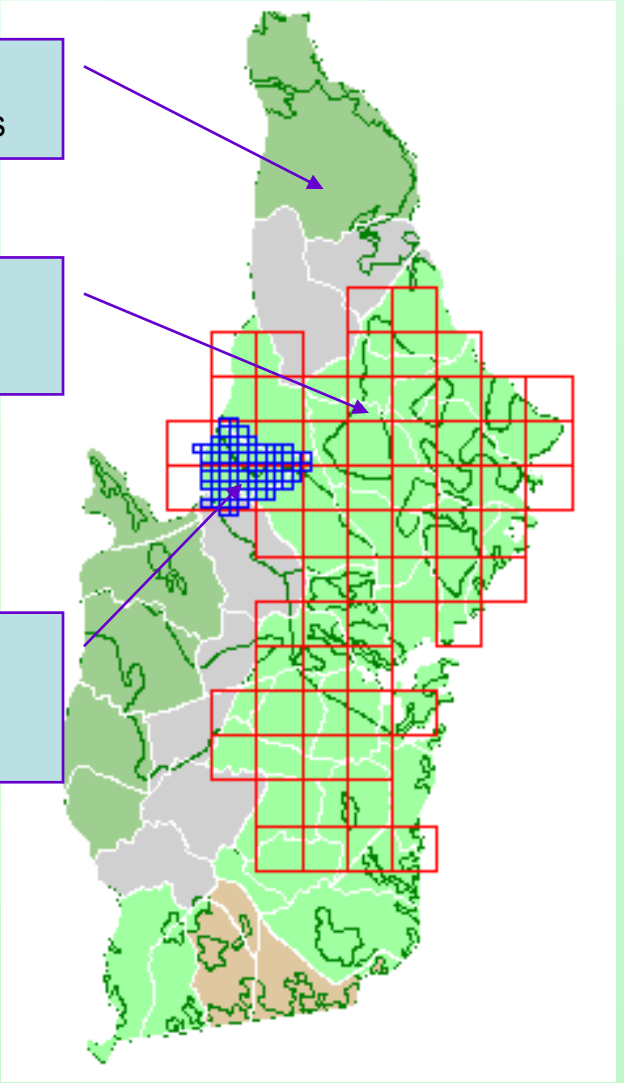
Concession management with MYRLIN

- 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

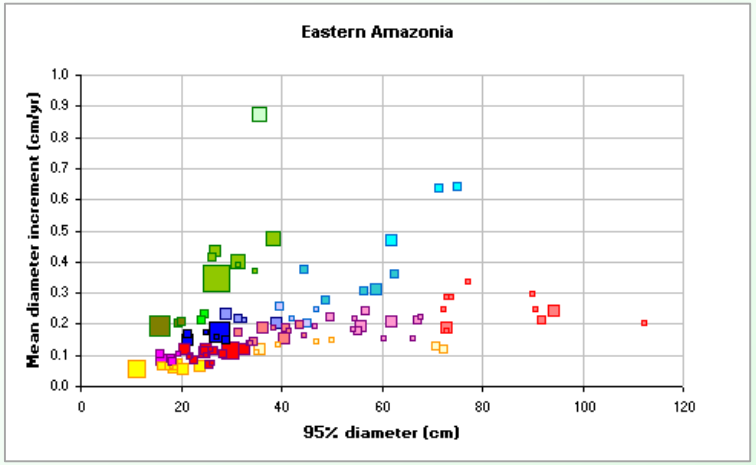
2. Management inventory
Felling units and coupé planning

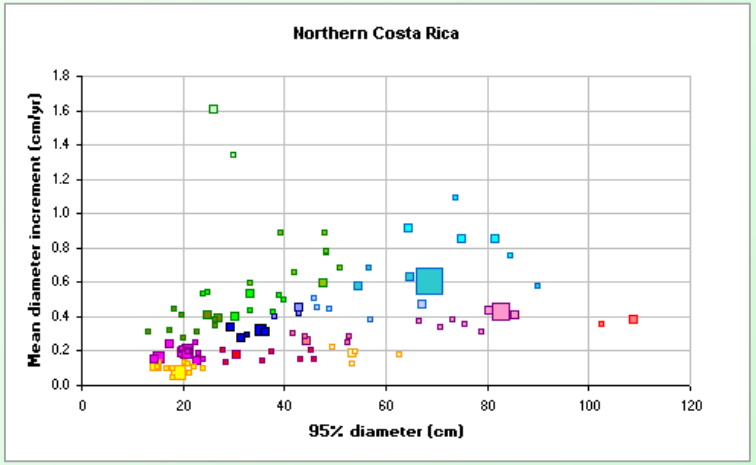
3. Stock mapping:
Sub-coupe mapping of trees and harvesting trails

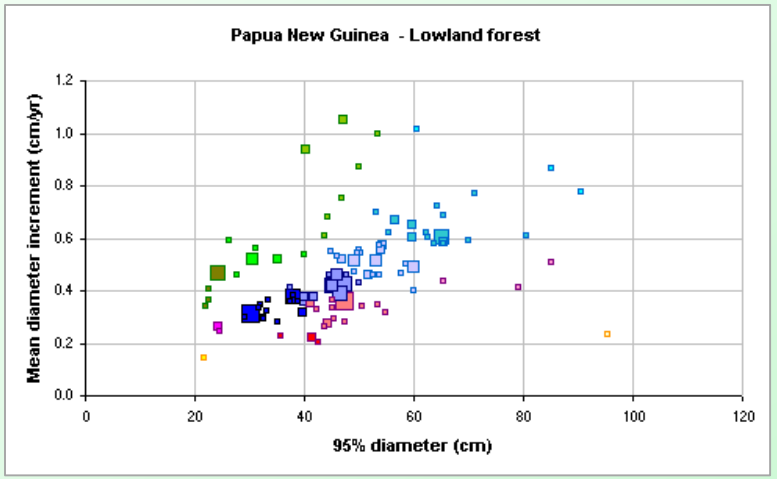


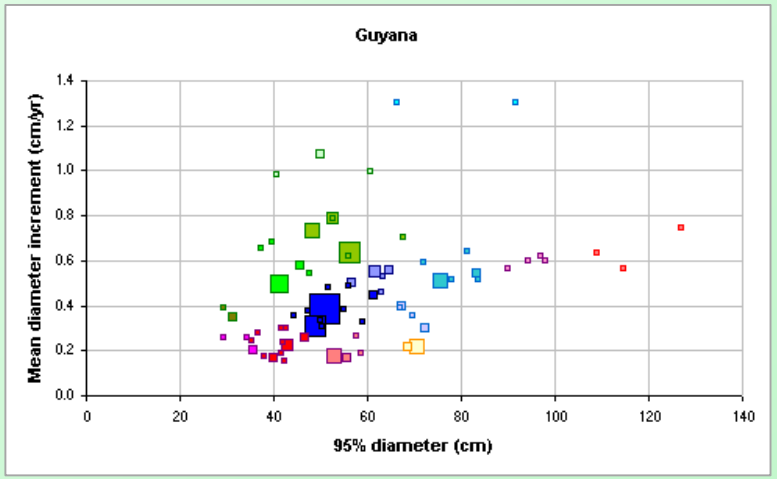
Pan-tropical growth rate comparisons

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.





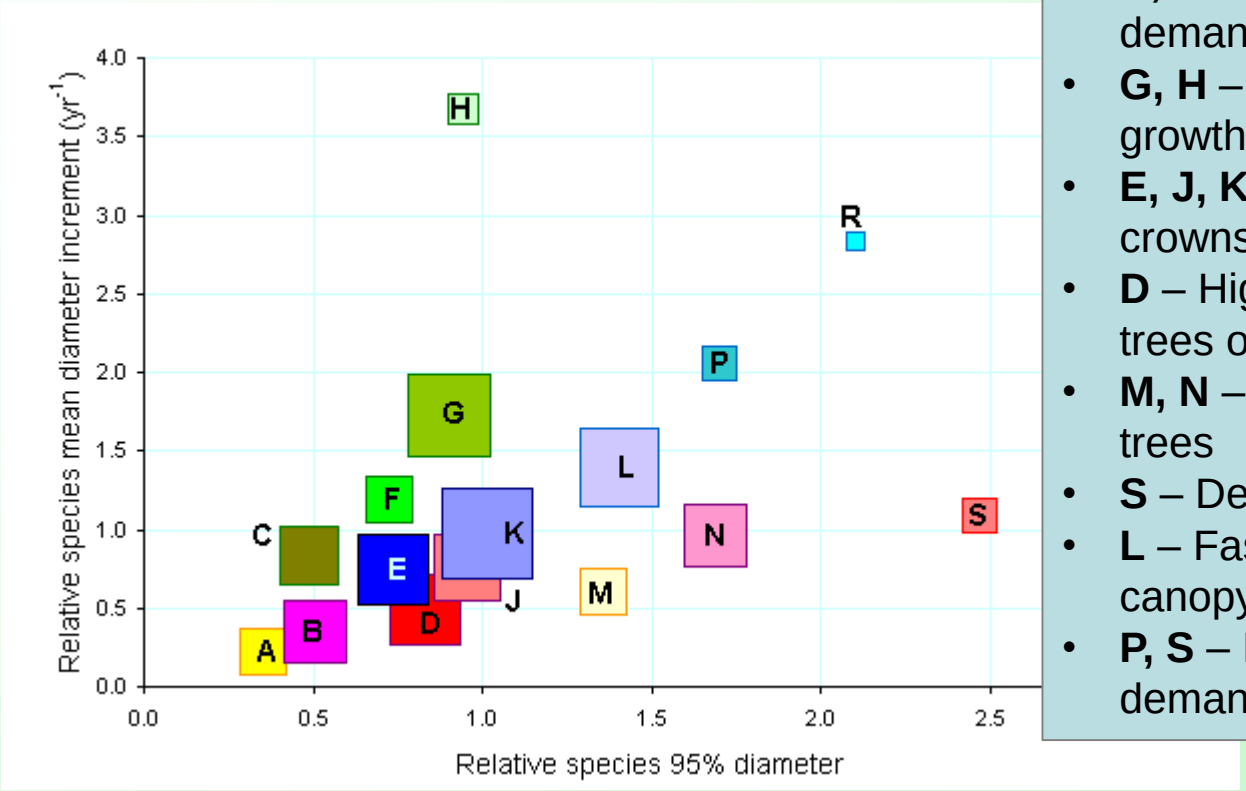




Data from tropical forests in Papua New Guinea, Guyana, Brazil, and Costa Rica show similar patterns

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.



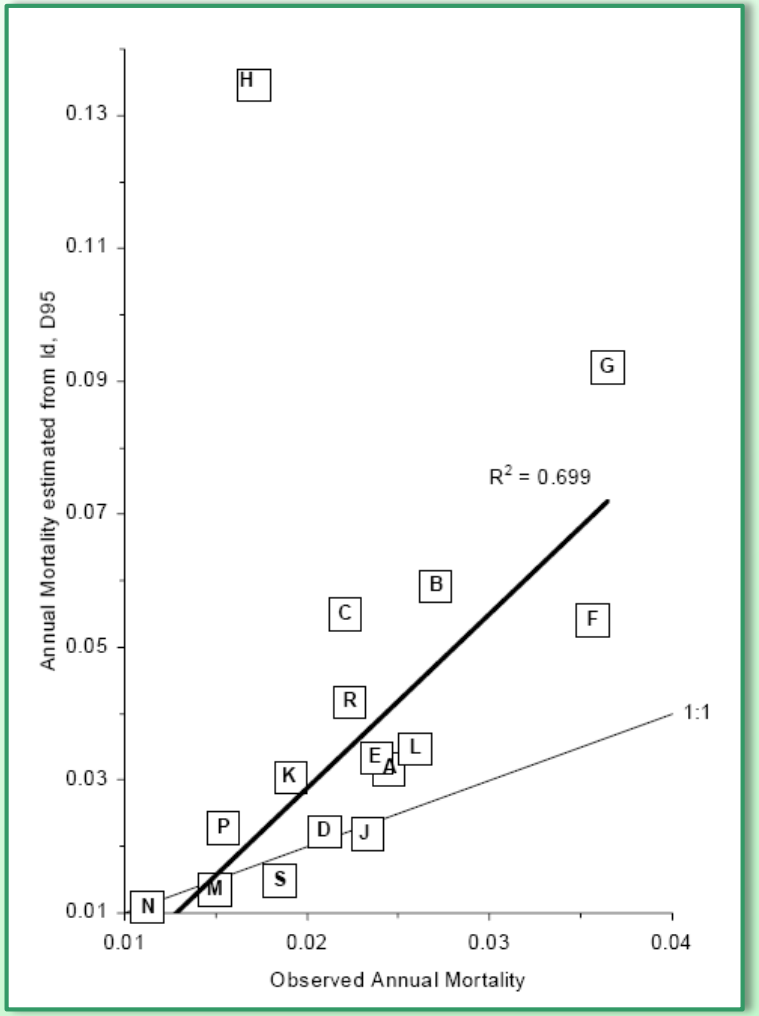
- **A, B** – Small persistent understorey trees
- **C, F** – Small trees growing in gaps, light demanding
- **G, H** – Pioneers, very light demanding, fast growth
- **E, J, K** – Typical mid-size trees, narrow crowns just in canopy,
- **D** – High density, shade tolerant smaller trees of upper understorey
- **M, N** – Slow growing, denser main canopy trees
- **S** – Dense, slow growing long lived emergent
- **L** – Faster growing, light demaning of main canopy
- **P, S** – Fast growing gap opportunist, light demanding, becoming canopy emergent.

Mortality and growth rate

- 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 show mortality estimated as:

$$AMR = 1 - 0.05^{[Dinc / D95]}$$

- 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

origin code	source	plot size m2	no. of plots	no. of trees	years measured	no. of genera
BR1	EMBRAPA Tapajos km-67	2500	36	13946	1981-97	138
BR2	EMBRAPA Tapajos km-114	2500	60	24876	1981-95	152
BR3	EMBRAPA Jari	10000	40	13498	1984-94	172
CR1	CODEFORSA 1-ha	10000	9	4857	1991-98	227
CR2	CODEFORSA ¼-ha	2500	27	3963	1992-98	159
CR3	Portico SA	10000	17	8811	1989-96	125
CR4	ITCR/DFID Project	4900	41	9958	1994-97	178
CR5	COSAFORMA/GTZ Project	600	34	2712	1991-96	113
PG1	PNG/ITTO Project	10000	70	26549	1990-98	274
GY1	Tropenbos Guyana	19600	15	6018	1993-97	94
GY2	Barama Co. Ltd., Guyana	10000	62	17153	1993-99	84
Total			**411**	**132341**		

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

Stand models, complex representation of stand dynamics

Diameter class

Historical
e.g. Brandeis (1890s)

GHAFOSIM
Ghana, 1989

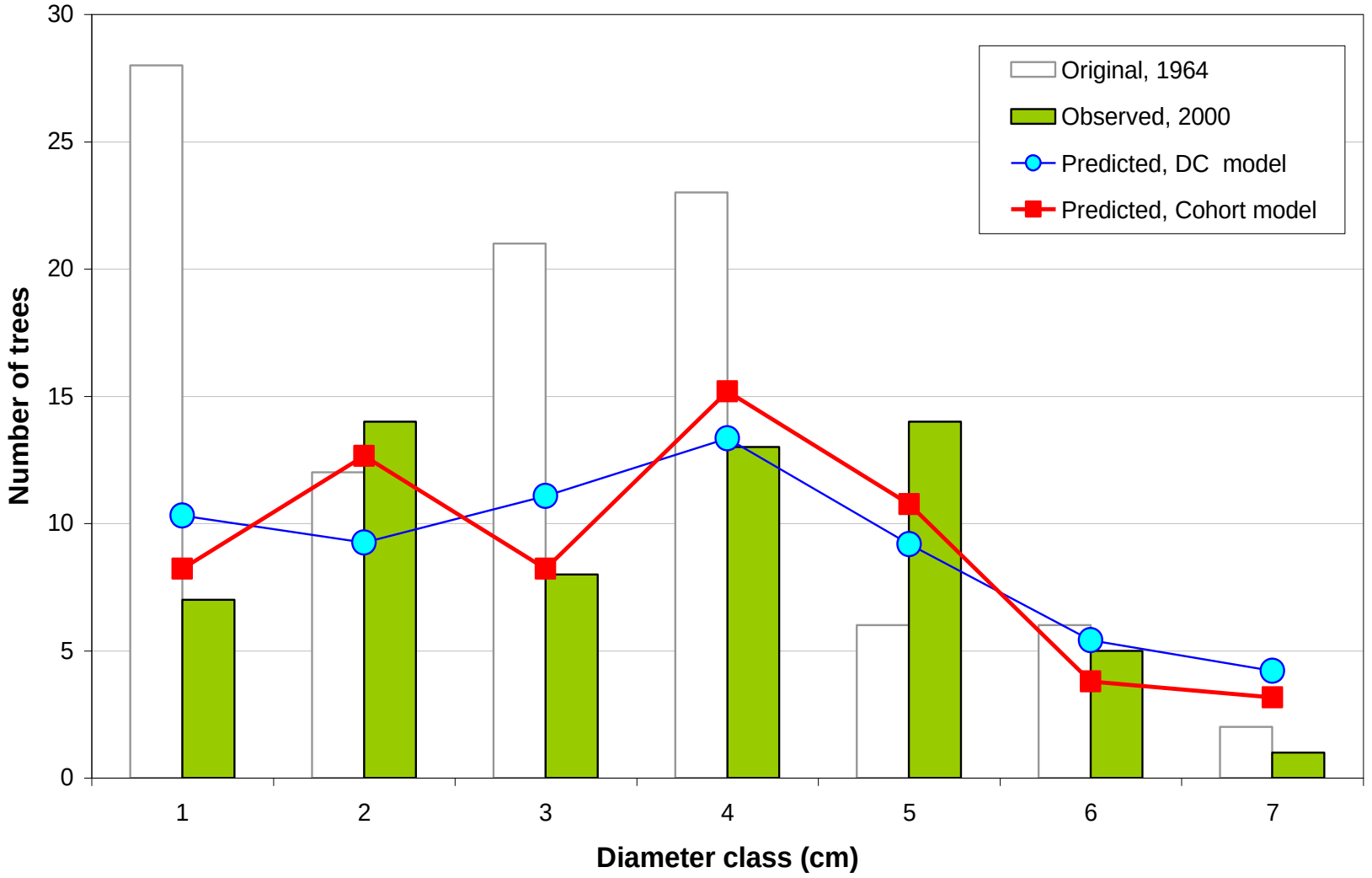
IWOPLAN
2001

MYRLIN
2002

Simplified models needed – complexity a constraint

Cohort vs Diameter Class

Guyana Greenheart data over 36 years



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