Modeling the development of uneven-aged stands by means a matrix model

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Bollandsås, O.M., Buongiorno, J. & Gobakken, T. 2008. Predicting the growth of stands of trees of mixed species and size: A matrix model for Norway. *Scandinavian Journal of Forest Research 23*, 167-178.

SNS - Forest Inventory, Management Planning and Modelling

ICELAND

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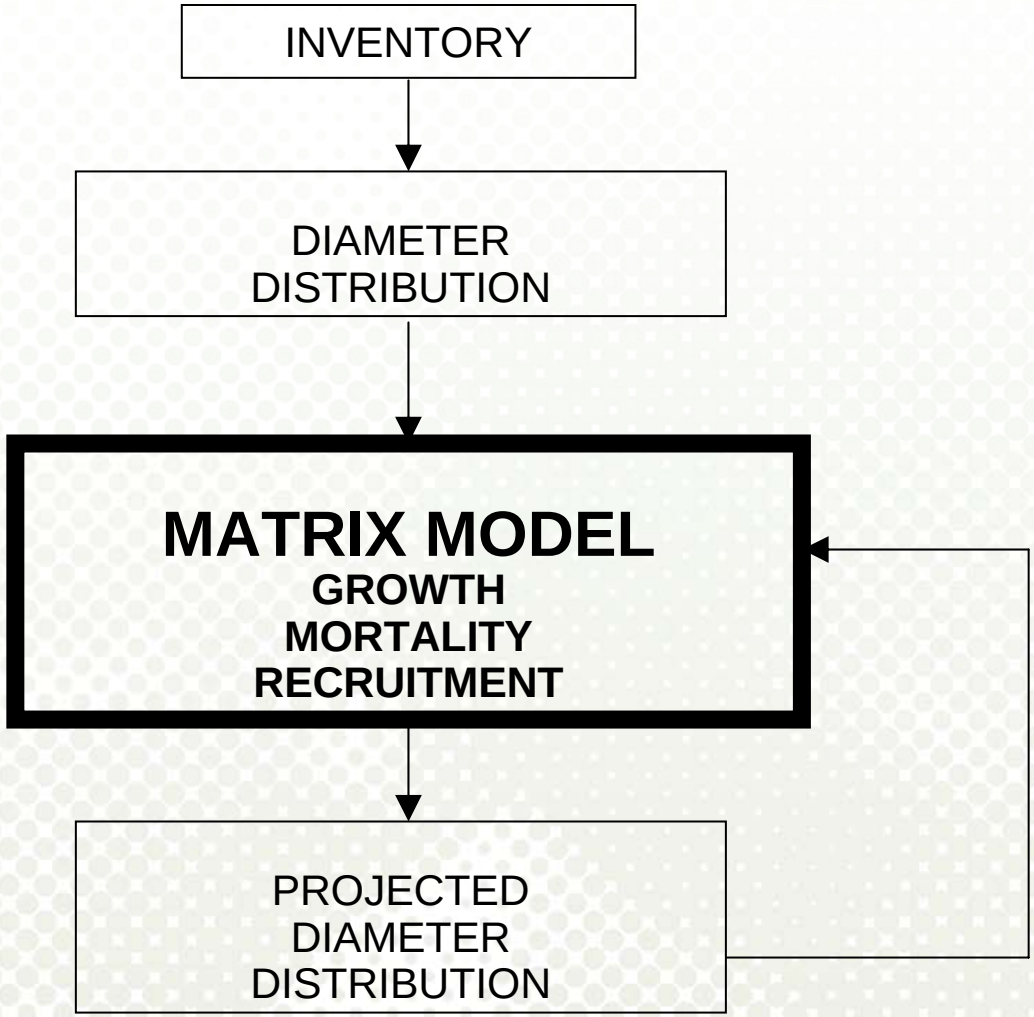
2005

Objective

- **To develop predictive models adapted to an uneven-aged forest structure.**
  - Dependent on competitive status
  - Input data → diameter distributions
- **Implement the models in a matrix model framework**
  - Diameter classes

Overview


INVENTORY
DIAMETER DISTRIBUTION
MATRIX MODEL
GROWTH
MORTALITY
RECRUITMENT
PROJECTED DIAMETER DISTRIBUTION

Data base for the models

- Data from the National Forest Inventory
- Approx. 220 000 trees observed two or three times
    - dbh, status
- Stand variables
    - BA, SI, N, LAT ...
- Species groups
    - Norway spruce
    - Scots pine
    - Birch
    - Other broadleaves

Recruitment.

- Two-step approach
  - Logit-model for recruitment probability
  - Mulitiplicative model for conditional number of recruits

$$\pi_i = \left(1 + \boldsymbol{e}^{-(\alpha_{i0} + \alpha_{i1} BA + \alpha_{i2} SI + \alpha_{i3} PBA_i)}\right)^{-1}$$

$$CR_i = \beta_{i0} BA^{\beta_{i1}} SI^{\beta_{i2}} PBA_i^{\beta_{i3}}$$

Diameter increment.

$$I_{5yr} = a + b_i \times \boldsymbol{SITE} + c_i \times \boldsymbol{competition} + d_i \times \boldsymbol{size}$$

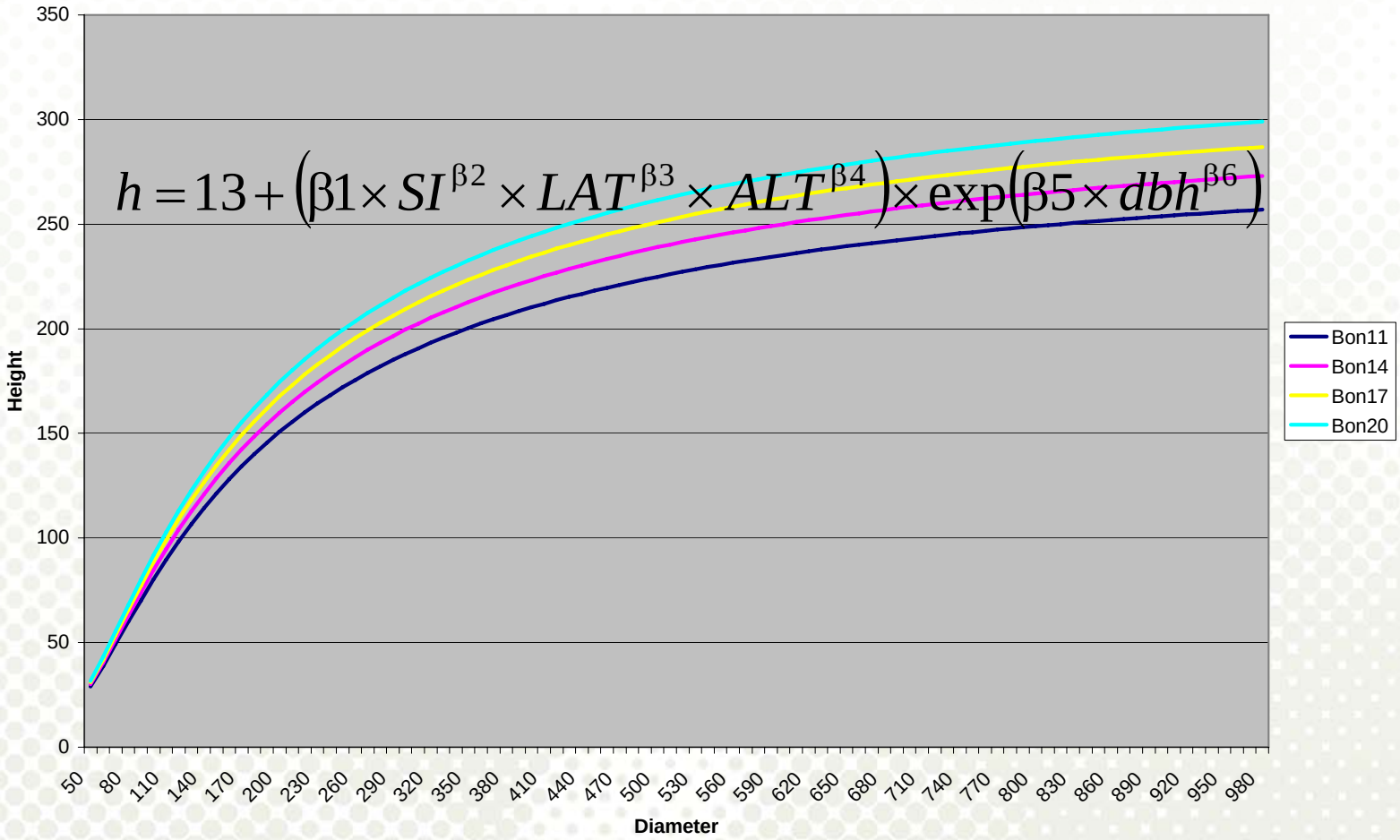
Mortality.

- Logit-model for the probability of mortality

$$m_i = \left(1 + \boldsymbol{e}^{-\left(\delta_{i0} + \delta_{i1}\boldsymbol{dbh} + \delta_{i2}\boldsymbol{dbh}^2 + \delta_{i3}\boldsymbol{BA}\right)}\right)^{-1}$$

Height model.

- Asymptotic height model



Matrix model (Paper IV).

$$a_{it} = 1 - b_{ij} - m_{ij}$$

$$y_{t+p} = G\,(y_t - h_t) + R$$

$$b_{ij} = \frac{I_{5yr}}{w}$$

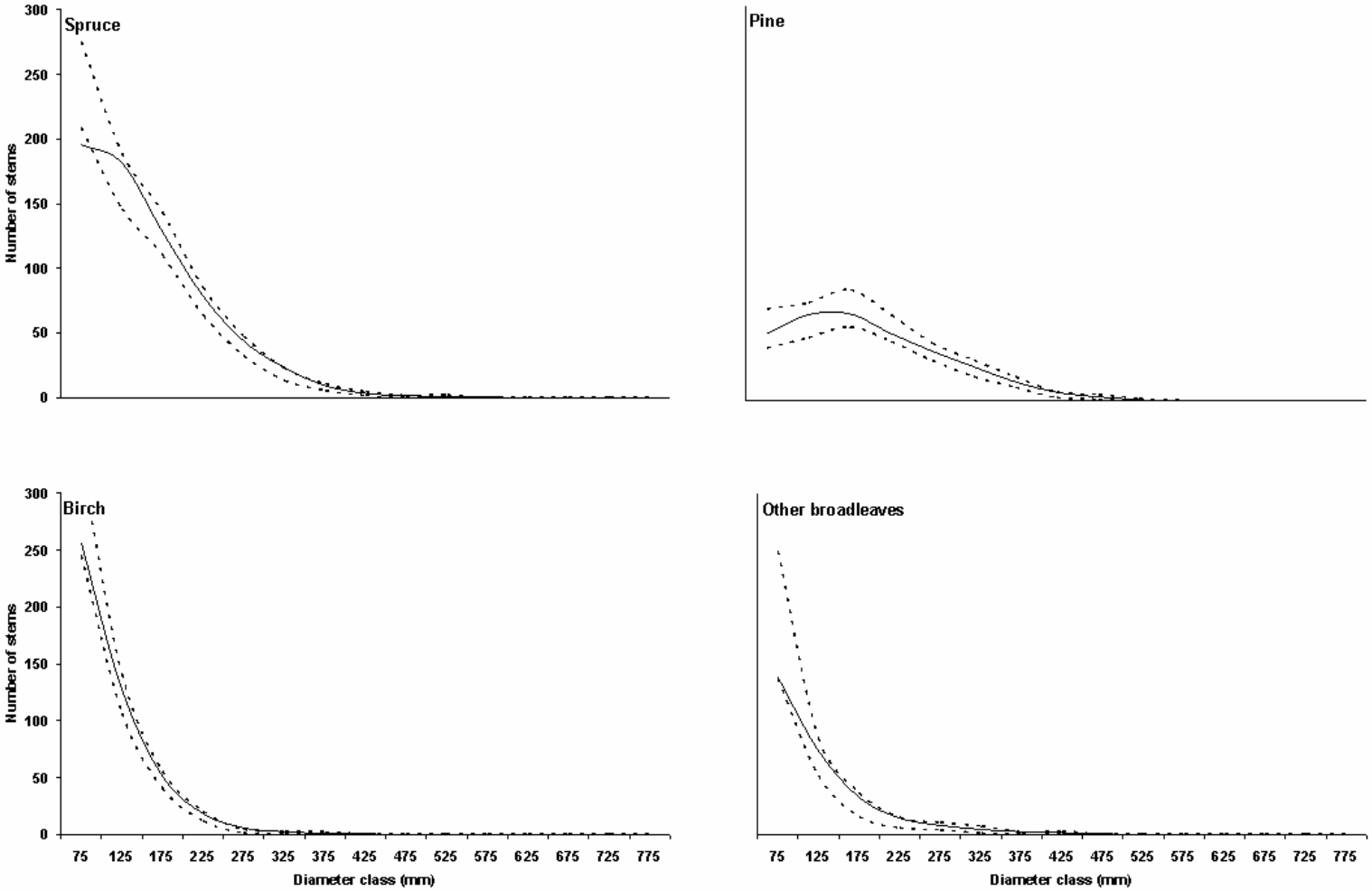
$$G_i = \begin{bmatrix} a_{i1} & 0 & \cdots & 0 & 0 \\ b_{i2} & a_{i2} & \cdots & 0 & 0 \\ 0 & b_{i3} & \ddots & 0 & 0 \\ \vdots & \cdots & \ddots & \ddots & \vdots \\ 0 & 0 & \cdots & b_{in} & a_{in} \end{bmatrix}$$

$$R_i = \begin{bmatrix} d_i \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

Results 1. Steady state estimates

	BA (m^2ha^{-1})	V (m^3ha^{-1})	N (ha^{-1})	d_g (mm)	h_L (dm)	BA_s (%)	BA_y (%)	BA_b (%)	BA_o (%)
	Observed old stands								
Stand 1[a]	34.2	361	1033	211	216	90.0	0.1	9.9[e]	
Stand 2[b]	45.5	635	630	303	289	100.0	0.0	0.0[e]	
	Predicted stand state								
Spruce[c]	42.5	381	826	257	216	93.7	0.7	3.0	2.6
Pine[c]	42.5	381	815	259	216	93.1	1.1	3.1	2.7
Birch[c]	42.6	381	825	257	216	93.7	0.7	3.0	2.6
Other broadleaves[c]	42.6	381	820	258	216	93.3	0.6	3.0	3.1
Mixed[d] SI = 6	31.5	218	572	268	169	73.1	23.0	2.7	1.2
Mixed[d] SI = 11	37.9	314	786	250	202	91.8	2.1	3.9	2.3
Mixed[d] SI = 17	46.8	448	849	266	228	94.2	0.3	2.3	3.2
Mixed[d] SI = 23	54.4	577	892	278	248	93.0	0.1	1.4	5.5

Results 2. Short term validation



Results 3. Steady state